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भारतीय मानक

इलेक्ट्रॉनिकी एवं विद्युतीय मदों के लिए बेसिक पर्यावरण परीक्षण कार्यविधियाँ

भाग 32 विशिष्टि लेखकों के लिए जानकारी — परीक्षण सारांश

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART 32 INFORMATION FOR SPECIFICATION WRITERS — TEST SUMMARIES

ICS 19.040

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Environmental Testing Procedures Sectional Committee, LTD 02

NATIONAL FOREWORD

This Indian Standard (Part 32) which is identical with IEC 60068-4 (1987) 'Basic environmental testing procedures — Part 4 : Information for specification writers — Test summaries' (duly incorporating Amendment 1 issued in 1992 and Amendment 2 issued in 1994) issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Environmental Testing Procedures Sectional Committee and approval of the Electronics and Information Technology Division Council.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to IEC 60068 series of standards for which Indian Standards IS 9000 and IS 9001 series also exist. These corresponding Indian Standards wherever available are to be substituted in their places of IEC Standards.

Only the English language text in the International Standard has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in IEC Publication.

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART 32 INFORMATION FOR SPECIFICATION WRITERS — TEST SUMMARIES

1. Object

To provide information in summarized form on the individual environmental tests in IEC Publication 68-2 to serve the purposes of specification writers and others when a knowledge of the detailed provisions of the complete standards is not required.

It should be particularly borne in mind by all concerned with laboratory testing that these summaries are not intended to be a substitute for the relevant complete standards.

2. General

The standards in Publication 68-2 for the individual environmental tests are based on the general considerations, including definitions and guidance, to be found in Publication 68-1. That standard gives an explanation of the method used to designate the various tests.

The uniform presentation of these summaries on a single page has resulted in varying degrees of 'reduction' of original texts which themselves vary widely in length and complexity. Although, in order to facilitate the use of the summaries in this publication, the presentation has been made as consistent as possible, it should be remembered that the original texts are of different dates and are the responsibility of IEC Technical Committee No. 50 or its Sub-Committees.

Tolerances have been omitted from these summaries; they can be found in Publication 68-2.

The information in Sub-clauses 2.1, 2.2 and 2.3, although not necessarily applicable to all the summaries, is of general application.

2.1 *Guidance*

Many of the standards in Publication 68-2 contain guidance on the application of the testing procedure and much of this is of particular value to specification writers and others who are not required to have a knowledge of the detailed provisions of a Test. In the case of these standards, the summaries will make no specific reference to guidance.

There are other cases, for example solar radiation testing (Publication 68-2-5), where guidance is to be found in another standard in the Publication 68-2 series (Publication 68-2-9 in the case of the example), or - and then described as 'background information' - in a standard in the Publication 68-3 series. In these cases, reference is made in the summary to the other standards concerned irrespective of their degree of relevance for specification writers in order that they can indicate fully in their specifications the sources of detailed information which laboratories will require. The standard will then be listed in Clause 5.

2.2 *Storage*

Guidance on the application of Tests in the Publication 68-2 series to simulate the effects of storage, from short-term to long-term, is given in Publication 68-2-48, to which reference should be made in appropriate cases.

2.3 *Mounting*

The mounting requirements for specimens to be subjected to certain of the vibration and shock tests covered by the summaries, namely shock and bump (Test Ea, Publication 68-2-27; Test Eb, Publication 68-2-29), sinusoidal and random vibration (Test Fc, Publication 68-2-6; Test Fd, Publications 68-2-34, 68-2-35, 68-2-36 and 68-2-37) and steady-state acceleration (Test Ga, Publication 68-2-7), are the subject of Publication 68-2-47, to which attention should be drawn in relevant specifications. This applies also, of course, when dealing with 'combined' or 'composite' tests, as defined in Clause 3, embodying one or more of the tests mentioned.

3. Definitions

The following list of generally-applicable definitions is based, with some editing, on those given in Publication 68-1.

For other definitions, refer to Publications 68-1 and 68-2.

3.1 *Test*

Complete series of operations implied by its title, normally comprising the following operations, when required:

a) pre-conditioning;
b) initial examination and measurements;
c) conditioning;
d) recovery;
e) final examination and measurements.

Note.- Intermediate measurements may be required during conditioning and/or recovery.

3.1.1 *Pre-conditioning*

Treatment of a specimen with the object of removing or partly counteracting the effects of its previous history.

3.1.2 *Conditioning*

Exposure of a specimen to environmental conditions in order to determine the effect of such conditions on the specimen.

3.1.3 *Recovery*

Treatment of a specimen, after environmental conditioning, in order that the properties of the specimen may be stabilized before measurement.

3.2 *Specimen*

Product designated to be tested in accordance with the procedures of IEC 68.

Note. - The term "specimen" includes any auxiliary parts or systems that are integral functional features of the specimen, for example systems for cooling and heating.

3.2.1 *Heat-dissipating specimen*

Specimen with the hottest point on its surface, measured in free air conditions and under the air pressure specified in Sub-clause 5.3.1 of IEC 68-1, more than 5 °C above the ambient temperature of the surrounding atmosphere after temperature stability has been reached.

3.2.2 *Non-heat dissipating specimen*

Specimen other than as defined in Sub-clause 3.2.1.

3.3 *Relevant specification*

Set of requirements to be satisfied by a product, indicating the procedure(s) necessary to determine whether the requirements given are satisfied.

3.4 *Severity*

Set of parameters for the conditioning of the specimen.

3.5 *Combined test*

Test in which two or more test environments act upon the specimen simultaneously.

3.6 *Composite test*

Test in which the specimen is exposed to two or more test environments in close succession.

4. List of test summaries

To facilitate the finding of the required summary, the summaries are listed in numerical order in subclause 4.1 and in alphabetical order in subclause 4.2. The Sheets for the individual summaries are filed in alphabetical order.

Note. - A reference to a publication is to the edition of the standard identified by its date on the corresponding test summary sheet and to all similarly identified amendments.

4.1 *Numerical list*

IEC Publication	*Test designation and title*	*Sheet*
68-2-1	Tests A: Cold	A/B-1
68-2-2	Tests B: Dry Heat (including First Supplement 68-2-2A)	A/B-1
68-2-3	Test Ca: Damp Heat, Steady State	C-1
68-2-5	Test Sa: Simulated Solar Radiation at Ground Level	S-1
68-2-6	Test Fc and Guidance: Vibration (Sinusoidal)	F-1
68-2-7	Test Ga and Guidance: Acceleration, Steady State	G-1
68-2-10	Test J and Guidance: Mould Growth	J-1
68-2-11	Test Ka: Salt Mist	K-1
68-2-13	Test M: Low Air Pressure	M-1
68-2-14	Test N: Change of Temperature	N-1
68-2-17	Test Q: Sealing	Q-1 to Q-8
68-2-18	Test R and Guidance: Water	R-1 to R-4
68-2-20	Test T: Soldering	T-1, T-3, T-4, T-5
68-2-21	Test U: Robustness of Terminations and Integral Mounting Devices	U-1 to U-6
68-2-27	Test Ea and Guidance: Shock	E-1
68-2-29	Test Eb and Guidance: Bump	E-2
68-2-30	Test Db and Guidance: Damp heat, cyclic (12 + 12-hour Cycle)	D-1
68-2-31	Test Ec: Drop and Topple, primarily for Equipment-type Specimens	E-3
68-2-32	Test Ed: Free fall	E-4
68-2-34	Test Fd: Random Vibration Wide Band - General Requirements	F-2
68-2-35	Test Fd: Random Vibration Wide Band - Reproducibility High	F-2
68-2-36	Test Fd: Random Vibration Wide Band - Reproducibility Medium	F-2

IEC Publication	*Test designation and title*	*Sheet*
68-2-37	Test Fdc: Random Vibration Wide Band - Reproducibility Low	F-2
68-2-38	Test Z/AD: Composite Temperature/Humidity Cyclic Test	Z-1
68-2-39	Test Z/AMD: Composite Sequential Cold, Low Air pressure and Damp Heat Test	Z-4
68-2-40	Test Z/AM: Combined Cold/Low Air Pressure Tests	Z-3
68-2-41	Test Z/BM: Combined Dry Heat/Low Air Pressure Tests	Z-3
68-2-42	Test Kc: Sulphur Dioxide Test for Contacts and Connections	K-3
68-2-43	Test Kd: Hydrogen Sulphide Test for Contacts and Connections	K-3
68-2-45	Test XA and Guidance: Immersion in Cleaning Solvents	X-1
68-2-50	Test Z/AFc: Combined Cold/Vibration (sinusoidal) tests for both Heat-dissipating and Non-heat-dissipating Specimens	Z-2
68-2-51	Test Z/BFc: Combined Dry Heat/Vibration (Sinusoidal) tests for both Heat-dissipating and Non-heat-dissipating Specimens	Z-2
68-2-52	Test Kb: Salt Mist, Cyclic (Sodium Chloride Solution)	K-2
68-2-54	Test Ta: Soldering. Solderability Testing by the Wetting Balance Method	T-2
68-2-55	Test Ee and Guidance: Bounce	E-5
68-2-56	Test Cb: Damp Heat, Steady State (for equipment)	C-2
68-2-57	Test Ff: Vibration, Time-history method	F-4
68-2-58	Test Td: Solderability, resistance to dissolution of metallization and to soldering heat of Surface Mounting Devices (SMD)	T-5
68-2-59	Test Fe: Vibration. Sine-beat Method	F-3
68-2-61	Test Z/ABDM: Climatic Sequence	Z-5
68-2-62	Test Ef: Impact, Pendulum Hammer	E-6
68-2-63	Test Eg: Impact, Spring Hammer	E-7
68-2-64	Test Fh: Vibration, broad-band random (digital control) and guidance	F-6
68-2-65	Test Fg: Vibration, acoustically induced	F-5

4.2 *Alphabetical list*

Test designation	*IEC Publication*	*Title*	*Sheet*
A, Aa, Ab, Ad	68-2-1	Tests A: Cold	A/B-1
B, Ba, Bb Bc, Bd	68-2-2	Tests B: Dry Heat (including First Supplement 68-2-2A)	A/B-1
Ca	68-2-3	Test Ca: Damp Heat, Steady State	C-1
Cb	68-2-56	Test Cb: Damp Heat, Steady State primarily for equipment	C-2
Db	68-2-30	Test Db and Guidance: Damp Heat Cyclic (12 + 12-hour Cycle)	D-1
Ea	68-2-27	Test Ea and Guidance: Shock	E-1
Eb	68-2-29	Test Eb and Guidance: Bump	E-2
Ec	68-2-31	Test Ec: Drop and Topple, primarily for Equipment-type Specimens	E-3
Ed	68-2-32	Test Ed: Free Fall	E-4
Ee	68-2-55	Test Ee and Guidance: Bounce	E-5
Ef	68-2-62	Test Ef: Impact, Pendulum Hammer	E-6
Eg	68-2-63	Test Eg: Impact, Spring Hammer	E-7
Fc	68-2-6	Test Fc and Guidance: Vibration (sinusoidal)	F-1
Fd	68-2-34	Test Fd: Random Vibration Wide Band - General Requirements	F-2
Fda	68-2-35	Test Fda: Random Vibration Wide Band - Reproducibility High	F-2
Fdb	68-2-36	Test Fdb: Random Vibration Wide Band - Reproducibilty Medium	F-2
Fdc	68-2-37	Test Fdc: Random Vibration Wide Band - Reproducibility Low	F-2
Fe	68-2-59	Test Fe: Vibration. Sine-beat Method	F-3
Ff	68-2-57	Test Ff: Vibration. Time-history Method	F-6
Fg	68-2-65	Test Fg: Vibration, acoustically induced	F-5
Fh	68-2-64	Test Fh: Vibration, broad-band random (digital control) and guidance	F-6
Ga	68-2-7	Test Ga and Guidance: Acceleration, Steady State	G-1
J	68-2-10	Test J: Mould Growth	J-1
Ka	68-2-11	Test Ka: Salt Mist	K-1

Test designation	*IEC Publication*	*Title*	*Sheet*
Kb	68-2-52	Test Kb: Salt Mist, Cyclic (Sodium Chloride Solution)	K-2
Kc	68-2-42	Test Kc: Sulphur Dioxide Test for Contacts and Connections	K-3
Kd	68-2-43	Test Kd: Hydrogen Sulphide Test for Contacts and Connections	K-3
M	68-2-13	Test M: Low Air Pressure	M-1
N, Na, Nb, Nc	68-2-14	Test N: Change of Temperature	N-1
Q	68-2-17	Test Q : Sealing	Q-1
Qa		Test Qa: Sealing of Bushes, Spindles and Gaskets	Q-2
Qc		Test Qc: Container Sealing, Gas Leakage	Q-3
Qd		Test Qd: Container Sealing, Seepage of Filling Liquid	Q-4
Qf		Test Qf: Immersion	Q-5
Qk		Test Qk: Sealing Tracer Gas Method with Mass Spectrometer	Q-6
Ql		Test Ql: Bomb Pressure Test	Q-7
Qm		Test Qm: Tracer Gas Sealing Test with internal pressurization	Q-8
R	68-2-18	Test R and Guidance	R-1
Ra		Falling drops	R-2
Rb		Impacting water	R-3
Rc		Immersion	R-4
Sa	68-2-5	Test Sa: Simulated Solar Radiation at Ground Level	S-1
T		Test T: Soldering	
Ta	68-2-20	Test Ta: Solderability of Wire and Tag Terminations	T-1
	68-2-54	Test Ta: Soldering - Solderability Testing by the Wetting Balance Method	T-2
Tb	68-2-20	Test Tb: Resistance of Components to Soldering Heat	T-3
Tc	68-2-20	Test Tc: Solderability of Printed Boards and Metal-clad Laminates	T-4
Td	68-2-58	Test Td: Solderability, Resistance to Dissolution of Metallization and to Soldering Heat of Surface Mounting Devices (SMD)	T-5

Test designation	*IEC Publication*	*Title*	*Sheet*
U	68-2-21	Test U: Robustness of Terminations and Integral Mounting Devices	
Ua_1		Test Ua_1: Tensile	U-1
Ua_2		Test Ua_2: Thrust	U-2
Ub		Test Ub: Bending	U-3
Uc		Test Uc: Torsion	U-4
Ud		Test Ud: Torque	U-5
Ue		Test Ue: Surface Mounting Devices (SMD) in the Mounted State (Applicable to SMD)	U-6
Xa	68-2-45	Test Xa and Guidance: Immersion in Cleaning Solvents	X-1
Z/ABDM	68-2-61	Test Z/ABDM: Climatic Sequence	Z-5
Z/AD	68-2-38	Test Z/AD: Composite Temperature/ Humidity Cyclic Test	Z-1
Z/AFc	68-2-50	Tests Z/AFc: Combined Cold/ Vibration (Sinusoidal) Tests for Both Heat-dissipating and Non-heat-dissipating Specimens	Z-2
Z/AM	68-2-40	Test Z/AM: Combined Cold/Low Air Pressure Tests	Z-3
Z/AMD	68-2-39	Test Z/AMD: Combined Sequential Cold, Low Air Pressure, and Damp Heat Test	Z-4
Z/BFc	68-2-51	Tests Z/BFc: Combined Dry Heat/ Vibration (Sinusoidal) Tests for both Heat-dissipating and Non-Heat-dissipating Specimens	Z-2
Z/BM	68-2-41	Test Z/BM: Combined Dry Heat/ Low Air Pressure Tests	Z-3

5. Lists of guidance documents

Many of the publications referred to in subclauses 4.1 and 4.2 contain guidance on the execution or application of the test procedure. In some cases, there is reference to other publications, containing guidance only, and these are listed in subclauses 5.1 and 5.2.

Note. - A reference to a publication is to the edition of the standard identified by its date on the corresponding test summary sheet and to all similarly identified amendments.

5.1 *Numerical list*

IEC Publication	*Test designation*	*Title*	*Sheet*
68-2-9	Sa	Guidance for Solar Radiation Testing	S-1
68-2-28	Ca, Db, Z/AD	Guidance for Damp Heat Tests	C-1, D-1, Z-1
68-2-33	N	Guidance on Change of Temperature Tests	N-1
68-2-44	T	Guidance on Test T: Soldering	T-1, T-3, T-4
68-2-46	Kd	Guidance to Test Kd: Hydrogen Sulphide Test for Contacts and Connections	K-3
68-2-49	Kc	Guidance to Test Kc: Sulphur Dioxide Test for Contacts and Connections	K-3
68-2-53	Z/AFc and Z/BFc	Guidance to Tests Z/AFc and Z/BFc: Combined Temperature (Cold and Dry Heat) and Vibration (Sinusoidal) tests	Z-2
68-3-1	A and B	Background Information: Section One - Cold and Dry Heat Tests	A/B-1
68-3-1A	A and B	First Supplement to Publication 68-3-1	A/B-1
68-3-2	Z/AM and Z/BM	Background Information: Section Two - Combined Temperature/Low Air Pressure Tests	Z-3
(260)	(Ca and Db)	Test Enclosures of Non-injection Type for Constant Relative Humidity	(C-1, D-1)
(355)	(Kb, Kc, Kd)	An Appraisal of the Problems of Accelerated Testing for Atmospheric Corrosion	(K-2, K-3)

5.2 *Alphabetical list*

Test Designation	*IEC Publication*	*Title*	*Sheet*
A and B	68-3-1	Background information: Section One - Cold and Dry Heat Tests	A/B-1
Ca	68-2-28	Guidance for Damp Heat Tests	C-1
(Ca)	(260)	Test enclosures of Non-injection Type for Constant Relative Humidity	(C-1)
Db	68-2-28	Guidance for Damp Heat Tests	D-1
(Db)	(260)	Test enclosures of Non-injection Type for Constant Relative Humidity	(D-1)
(Kb, Kc, Kd)	(355)	An Appraisal of the Problems of Accelerated Testing for Atmospheric Corrosion	(K-2, K-3)
Kc	68-2-49	Guidance for Test Kc: Sulphur Dioxide Tests for Contacts and Connections	K-3
Kd	68-2-46	Guidance for Test Kd: Hydrogen Sulphide Tests for Contacts and Connections	K-3
N	68-2-33	Guidance on Change of Temperature Tests	N-1
R	68-2-18	Test R and Guidance: Water	R-1
Sa	68-2-9	Guidance for Solar Radiation Testing	S-1
T	68-2-44	Guidance on Test T: Soldering	T-1, T-3 T-4
Z/AD	68-2-28	Guidance for Damp Heat Tests	Z-1
Z/AFc	68-2-53	Guidance to Tests Z/AFc and Z/BFc: Combined Temperature (Cold and Dry Heat) and Vibration (Sinusoidal) Tests	Z-2
Z/AM	68-3-2	Background Information Section Two - Combined Temperature/Low Air Pressure Tests	Z-3

Test Designation	*IEC Publication*		
Z/BFc	68-2-53	Guidance to Tests Z/AFc and Z/BFc: Combined Temperature (Cold and Dry Heat) and Vibration (Sinusoidal) Tests	Z-2
Z/BM	68-3-2	Background Information: Section Two - Combined Temperature/Low Air Pressure Tests	Z-3

6. Test summaries

The sheets for the individual summaries in this clause are identified by the letters identifying the test(s) considered and are filed in alphabetical order of the related sheet reference. Current sheets with their identifying date of issue are listed below in the order in which they are filed. This list, together with these introductory sentences in Clause 6, will be reissued every time that new individual summaries are added or existing ones are revised or withdrawn.

Sheet	*Issue date*	*Test designation(s)*	*IEC Publication(s)*
A/B-1	1991	Tests A and	68-2-1and
	1974	Tests B	68-2-2
C-1	1991	Test Ca	68-2-3
C-2	1991	Test Cb	68-2-56
D-1	1991	Test Db	68-2-30
E-1	1987	Test Ea	68-2-27
E-2	1987	Test Eb	68-2-29
E-3	1969	Test Ec	68-2-31
E-4	1991	Test Ed	68-2-32
E-5	1987	Test Ee	68-2-55
E-6	1991	Test Ef	68-2-62
E-7	1991	Test Eg	68-2-63
F-1	1982	Test Fc	68-2-6
F-2	1973	Test Fd	68-2-34,
		Test Fda	68-2-35
		Test Fdb	68-2-36
		Test Fdc	68-2-37
F-3	1991	Test Fe	68-2-59
F-4	1991	Test Ff	68-2-57
F-5	1993	Test Fg	68-2-65
F-6	1993	Test Fh	68-2-64
G-1	1983	Test Ga	68-2-7
J-1	1991	Test J	68-2-10
K-1	1981	Test Ka	68-2-11
K-2	1984	Test Kb	68-2-52
K-3	1982, 1976	Test Kc and	68-2-42 and
		Test Kd	68-2-43

Sheet	*Issue date*	*Test designation(s)*	*IEC Publication(s)*
M-1	1983	Test M	68-2-13
N-1	1984	Test N	68-2-14
Q-1	1991	Test Q	68-2-17
Q-2	1978	Test Qa	68-2-17
Q-3	1978	Test Qc	68-2-17
Q-4	1978	Test Qd	68-2-17
Q-5	1978	Test Qf	68-2-17
Q-6	1991	Test Qk	68-2-17
Q-7	1978	Test Ql	68-2-17
Q-8	1991	Test Qm	68-2-17
R-1	1991	Test R	68-2-18
R-2	1989	Test Ra	68-2-18
R-3	1989	Test Rb	68-2-18
R-4	1989	Test Rc	68-2-18
S-1	1975	Test Sa	68-2-5
T-1	1979	Test Ta	68-2-20
T-2*	1985	Test Ta*	68-2-54
T-3	1979	Test Tb	68-2-20
T-4	1979	Test Tc	68-2-20
T-5	1989	Test Td	68-2-58
U-1	1983	Test Ua1	68-2-21
U-2	1983	Test Ua2	68-2-21
U-3	1983	Test Ub	68-2-21
U-4	1983	Test Uc	68-2-21
U-5	1983	Test Ud	68-2-21
U-6	1991	Test Ue	68-2-21
X-1	1980	Test XA	68-2-45
Z-1	1974	Test Z/AD	68-2-38
Z-2	1983	Tests Z/AFc and Tests Z/BFc	68-2-50 and 68-2-51
Z-3	1976	Test Z/AM and Test Z/BM	68-2-40 and 68-2-41
Z-4	1976	Test Z/AMD	68-2-39
Z-5	1991	Test Z/ABDM	68-2-61

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* Sheet T-1 deals with Methods 1, 2 and 3 of Test Ta of IEC 68-2-20.

COLD: Tests A - IEC 68-2-1 (1990)
DRY HEAT: Tests B - IEC 68-2-2 (1974)* and 68-2-2A (1976)

See also: IEC 68-3-1: Background information. Section One - Cold and dry heat tests (1974) and 68-3-1A (1978).

1 INTRODUCTION

IEC 68-2 deals with cold and dry heat tests applicable both to heat-dissipating and non heat-dissipating specimens.

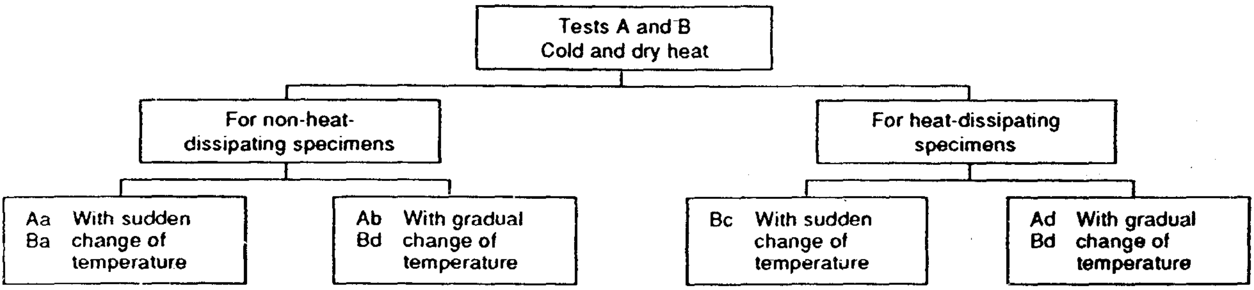
They are subdivided into tests with sudden and gradual change of temperature.

The object of these tests is to determine the ability of components, equipment or other articles to be used or stored at low or high temperature. They do not permit the assessment of the ability of specimens to withstand or operate during temperature variations, for which it is necessary to use Test N: Change of temperature.

The procedures given in these tests are normally intended for specimens which achieve temperature stability during the performance of the test.

Tests Aa, Ba and Bc shall be used only when it is known that the effects of a sudden change of temperature are not detrimental to the test specimen.

The cold and dry heat tests are subdivided as in the block diagram below:


Tests A and B
Cold and dry heat
For non-heat-dissipating specimens
For heat-dissipating specimens
Aa Ba With sudden change of temperature
Ab Bd With gradual change of temperature
Bc With sudden change of temperature
Ad Bd With gradual change of temperature

2 GENERAL DESCRIPTION

The specimen is at the ambient temperature of the laboratory when introduced into the chamber. For tests with sudden change of temperature the chamber is at the temperature appropriate to the degree of severity as specified in the relevant specification; for the tests with gradual change of temperature it is at the temperature of the laboratory. In the latter case the temperature is then changed to the temperature appropriate to the degree of severity specified in the relevant specification.

After temperature stability of the specimen has been reached the specimen is exposed to the test conditions for the specified duration.

Non-heat-dissipating specimens under test are normally in non-operating conditions. Forced air circulation is normally used for this test. For heat-dissipating specimens the relevant specification defines the functioning of the specimens under test and testing with no forced air circulation is the preferred method. Forced air circulation may, however, be used when it is difficult or impossible to meet the conditions specified for testing without air circulation. Alternative methods for this situation are given in IEC 68-2.

3 SEVERITIES

Tests A: Cold			Tests B: Dry heat			
Temperature °C		Duration h	Temperature °C 1)			Duration h
−65	−10	2	+200	+100	+40	2
−55	−5	16	+175	+85	+30	16
−40	+5	72	+155	+70		72
−25		96	+125	+55		96

1) In the absence of other considerations, temperatures above 200 °C and up to 1 000 °C should be chosen from the following values: 250 °C, 315 °C, 400 °C, 500 °C, 630 °C, 800 °C, 1 000 °C.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

The relevant specification shall identify the test to be used (including the following details) taking account of clause 1 of this summary.

a) Pre-conditioning.
b) Initial measurements.
c) Details of mounting or supports.
d) State of specimen including cooling system during conditioning.
e) Severity, temperature and duration of exposure
f) Measurements and/or loading during conditioning.
g) Recovery if non-standard.
h) Final measurements.
i) Any deviation in procedure as agreed upon between customer and supplier

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* The 1987 reprint includes IEC 68-2-2A.

DAMP HEAT, STEADY STATE: Test Ca - IEC 68-2-3 (1969) and Amendment 1 (1984)

See also: IEC 68-2-28: Guidance for damp heat tests (1990) and IEC 260: Test enclosures of non-injection type for constant relative humidity (1968).

1 INTRODUCTION

The object of this test is to determine the suitability of components, equipment or other electrotechnical products for use and storage under conditions of high relative humidity.

This test is primarily intended to permit the observation of the effects of high humidity at constant temperature over a prescribed period.

2 GENERAL DESCRIPTION

Specimens are exposed to a damp heat environment which is maintained at a temperature of 40 °C and a relative humidity of 93 %.

3 SEVERITIES

The exposure time is chosen from the following:

4 days
10 days
21 days
56 days

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Pre-conditioning procedure.
b) Electrical and mechanical checks to be made prior to the test.
c) State of the specimen as introduced into the chamber.
d) Severity.
e) Loading during conditioning.
f) Electrical and mechanical checks to be made during conditioning and the period(s) after which they shall be performed.
g) Special precautions to be taken regarding removal of surface moisture.
h) Recovery conditions if other than standard.
i) Electrical and mechanical checks to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters.

DAMP HEAT, STEADY STATE, PRIMARILY FOR EQUIPMENT: Test Cb - IEC 68-2-56 (1988)

1 INTRODUCTION

The object of this test is to determine the suitability of electrotechnical products, primarily for equipment, for use and storage under conditions of high humidity.

This test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation of the specimen over a prescribed period.

The test is particularly applicable to large equipment or equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of pre-heating and the maintenance of specified conditions during the installation period.

2 GENERAL DESCRIPTION

Specimens are exposed to a damp heat environment.

3 SEVERITIES

Combinations of temperature and relative humidity shall be selected from the following:

30 ± 2 °C	93 ± 3 % H.R.
30 ± 2 °C	85 ± 3 % H.R.
40 ± 2 °C	93 ± 3 % H.R.
40 ± 2 °C	85 ± 3 % H.R.

Preferred test durations: 2, 4, 10, 21 days.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Specific mounting structures, if required.
b) Test severity:
  - temperature,
  - relative humidity,
  - duration.
c) Initial measurements.
d) Conditioning.
e) Intermediate measurements.
f) Recovery conditions.
g) Final measurements.

Db

DAMP HEAT, CYCLIC (12 + 12-HOUR CYCLE): Test Db - IEC 68-2-30 (1980) and Amendment 1 (1985)

See also IEC 68-2-28: Guidance for damp heat tests (1990) and IEC 260 Test enclosures of non-injection type for constant relative humidity (1968).

1 INTRODUCTION

The object of this test is to determine the suitability of components, equipment or other electrotechnical products for use and storage under conditions of high humidity when combined with cyclic temperature changes and, in general, producing condensation on the surface of the specimen.

2 GENERAL DESCRIPTION

This test comprises one or more temperature cycles between 25 °C and the upper temperature of the cycle in which the relative humidity is maintained at a high level.

Two variants of the cycle are given; they are identical except for the temperature fall period. During this part of the cycle, variant 2 allows wider tolerances of relative humidity and rate of temperature fall.

3 SEVERITIES

The severity is chosen from the following:

a) upper temperature: 40 °C,
number of cycles: 2, 6, 12, 21, 56;
b) upper temperature: 55 °C,
number of cycles: 1, 2, 6.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Severity.
b) Initial measurements.
c) State of the specimen during conditioning.
d) Details of mounting or supports.
e) Variant 1 or 2.
f) Intermediate measurements.
g) Recovery conditions.
h) Special precautions to be taken regarding the removal of surface moisture.
i) Electrical and mechanical checks to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters (final measurements).

SHOCK: Test Ea - Publication 68-2-27 (1987).

1. INTRODUCTION

The object of this test is to reveal mechanical weakness and/or degradation in specified performance in specimens for applications in which they will be subjected to non-repetitive mechanical shocks. It may also be used to determine their structural integrity and as a means of quality control. It is intended as a means of producing in the specimen, the effects of relatively infrequent non-repetitive shocks likely to be encountered by equipments and components in service or during transportation.

2. GENERAL DESCRIPTION

For the purpose of this test the specimen is always fastened to the fixture or the table of the shock testing machine during conditioning and is subjected to a pulse (acceleration against time) whose shape can be either half-sine (most generally applicable), final-peak saw-tooth, or trapezoidal (not primarily intended for component type specimens) as prescribed in the relevant specification.

3. SEVERITIES

Peak acceleration		Corresponding duration of the nominal pulse
g_n	(Equivalent m/s^2)	ms
5	(50)	30
15	(150)	11
30	(300)	18
30	(300)	11
30	(300)	6
50	(500)	11
50	(500)	3
100	(1000)	11
100	(1000)	6
200	(2000)	6
200	(2000)	3
500	(5000)	1
1000	(10000)	1
1500	(15000)	0.5
3000	(30000)	0.2

In the above table the preferred combinations of peak acceleration and corresponding duration of the nominal pulse are underlined.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Pulse shape.
b) Tolerances, special cases.
c) Velocity change, special cases.
d) Transverse motion, special cases.
e) Method of mounting.
f) Severity.
g) Pre-conditioning.
h) Initial measurements.
i) Directions and number of shocks, in special cases only.
j) Operating modes and functional monitoring.
k) Acceptance and rejection criteria.
l) Recovery.
m) Final measurements.
n) High frequency cut-off.

BUMP: Test Eb - Publication 68-2-29 (1987).

1. INTRODUCTION

The object of this test is to reveal the accumulated damage or degradation in specimens for applications in which they will be subjected to repetitive shocks. It may also be used to assess their structural integrity. It is intended as a means of producing, in the specimen, effects similar to those resulting from repetitive shocks likely to be encountered by equipments and components in service or during transportation.

The test is primarily intended for unpackaged specimens and for items in their transport case, when the latter may be considered as part of the specimen itself.

2. GENERAL DESCRIPTION

For the purpose of this test the specimen is always fastened to the fixture or the table of the bump tester during conditioning and is subjected to repeated half-sine pulses for which the number, peak acceleration and duration is prescribed by the relevant specification.

3. SEVERITIES

The severity is defined as a combination of peak acceleration, duration and number of bumps. The number of bumps in each direction is chosen from 100, 1000, 4000.

Peak acceleration		Corresponding duration of the nominal pulse
g_n	(Equivalent m/s^2)	ms
10	(100)	16
15	(150)	6
25	(250)	6
40	(400)	6
100	(1000)	2

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Tolerances, special cases.
b) Velocity change, special cases.
c) Transverse motion, special cases.
d) Method of mounting.
e) Severity.
f) Pre-conditioning.
g) Initial measurements
h) Directions and number of bumps, in special cases only.
i) Operating modes and functional monitoring.
j) Acceptance and rejection criteria.
k) Recovery.
l) Final measurements.

DROP AND TOPPLE, PRIMARILY FOR EQUIPMENT-TYPE SPECIMENS: TEST Ec - Publication 68-2-31 (1969) and Amendment No. 1 (1982).

1. INTRODUCTION

The object of this test, which is primarily for equipment type specimens, is to assess the effects upon a specimen of knocks and jolts likely to occur during repair work or rough handling in use, on a table or bench.

It may also be used to demonstrate a minimum degree of robustness for the purpose of assessing safety requirements.

It is primarily intended for specimens out of their packing and for items in their transport cases, when the latter may be considered as part of the specimen itself.

2. GENERAL DESCRIPTION

The test consists of three distinct procedures:

a) Dropping on to a face.
b) Dropping on to a corner.
c) Toppling (or pushover).

The relevant specification shall state the procedure to be used, taking into account the dimensions and the positions of the centre of gravity of the specimen.

3. SEVERITIES

a) Dropping on to a face

One edge of the specimen is lifted to 25 mm, 50 mm or 100 mm, as prescribed by the relevant specification, or so that an angle of 30° is formed, whichever condition is the less severe. It is then allowed to fall freely.

The specimen is subjected to one drop about each of the four bottom edges.

b) Dropping on to a corner

A wooden block 10 mm high is placed under one corner and a 20 mm wooden block under an adjacent corner of one of the bottom edges. The other corner, adjacent to the 10 mm block is raised to 25 mm, 50 mm or 100 mm, as prescribed in the relevant specification, or so that an angle of 30° is formed, whichever condition is the less severe. It is then allowed to fall freely.

The specimen is subjected to one drop on each of four bottom corners by applying the test along four bottom edges in turn.

c) Topple (or pushover)

The specimen is tilted about one bottom edge until it reaches a position of instability. It is then allowed to fall.

The specimen is subjected to one topple about each of four bottom edges.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Initial measurements.
b) Conditioning procedure.
c) Fitting of cables, covers, etc.
d) Whether or not the specimen is operational during the test.
e) Edges to be used in the test, where there are more than four bottom edges.
f) The height of drop on to a face.
g) The height of drop on to a corner.
h) Final measurements.

Ed

FREE FALL: Test Ed - IEC 68-2-32 (1975) and Amendment 2 (1990)

1 INTRODUCTION

This test is divided into: Procedure 1 - Free fall, and Procedure 2 - Free fall - repeated. The first simulates falls which a specimen, normally in the unpacked state, could undergo during handling.

The second simulates repeated falls, for example by means of a tumbling barrel. Such repeated falls may occur to devices such as connectors or small remote control units which are normally attached to cables during use.

2 GENERAL DESCRIPTION

2.1 *Free fall*

The specimen is dropped freely from a prescribed height on to a smooth, hard, rigid, test surface, normally of concrete or steel.

2.2 *Free fall - repeated*

The specimen is allowed to fall a prescribed number of times from a height of 500 mm at a rate of approximately 10 falls per min on to a smooth, hard, rigid test surface which, unless otherwise prescribed by the relevant specification, is of steel of 3 mm thickness backed by wood between 10 mm and 19 mm in thickness. These requirements can be fulfilled by using a rotating or tumbling barrel.

3 SEVERITIES

3.1 *Free fall*

The height of fall is selected from the following values, 25 mm, 50 mm, 100 mm, 250 mm, 500 mm, 1 000 mm. The values underlined are preferred. It may not be appropriate for heavy equipment to be subjected to the higher severities.

3.2 *Free fall - repeated*

The total number of falls is selected from the following values: 50, 100, 200, 500, 1 000.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

4.1 *Free fall*

a) Test surface if other than concrete or steel.
b) Height of fall.
c) Initial measurements.
d) Attitude from which the specimen is dropped.
e) Number of falls, if other than two. Unless otherwise prescribed in the relevant specifications, the specimen shall be subjected to two falls form each prescribed attitude.
f) Final measurements.

4.2 *Free fall - repeated*

a) Initial measurements.
b) Number of falls.
c) Final measurements.
d) Type of cable to be attached.

BOUNCE: Test Ee - Publication 68-2-55 (1987).

1. INTRODUCTION

The object of this test is to determine the ability of a specimen to withstand the effects of bouncing, such as is caused, for example, by random shocks during transport as loose cargo. It may also be used to determine the structural integrity of specimens.

Note.- In practice, this test is primarily applicable to equipment-type specimens.

This test is primarily intended for specimens prepared for transportation, including those in their transport case when the latter may be considered as part of the specimen itself.

2. GENERAL DESCRIPTION

For this test, the specimen prepared as for transportation, with or without its transport case, is placed, without being attached, on the platform of the bounce tester during conditioning. The motion of the platform may be "synchronous circular" (Method A) or "non-synchronous" (Method B), varying cyclically between a linear vertical and an oscillatory motion.

Normally, for this test the specimen is not functioning and it is sufficient that it should survive the conditioning.

3. SEVERITIES

The duration of the conditioning expressed in minutes, exclusive of recovery periods, is selected from the following values: 180, 60, 15, 5. This duration is divided equally between the specified attitudes.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Acceptance and rejection criteria.
b) Test method and motion of the platform.
c) Testing with or without the transport case.
d) Size of test facility.
e) Severity.
f) Pre-conditioning.
g) Initial measurements.
h) Attitude and orientation of the specimen.
i) Stacking requirements.
j) Final measurements.

Impact, Pendulum hammer: Test Ef - IEC 68-2-62 (1991)

1 INTRODUCTION

The object of this test is to determine the ability of a specimen to withstand specified values of impact, principally to demonstrate mechanical robustness when assessing the safety of a specimen, in particular electrical accessories such as switches and lampholders.

2 GENERAL DESCRIPTION

The test apparatus, of which an example is described in annex A, applies an impact value horizontally to the specimen mounted on the apparatus (0,15 J to 0,50 J).

The relevant specification shall state whether the specimen is required to operate during impact and if functional monitoring is required.

3 SEVERITIES

The severity is defined by the number of impacts, which is five unless otherwise prescribed by the relevant specification, in each attitude of the specimen, and the nominal height of fall (in mm), which is selected by the relevant specification from the following:

Height of fall: 75; 100; 150; 200; 250.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Method of mounting, if other than direct.
b) Height of fall*.
c) Number of impacts (in each attitude), if other than 5.
d) Pre-conditioning.
e) Initial measurements.
f) Attitudes and impact locations*.
g) Operating mode and functional monitoring*.
h) Acceptance and rejection criteria*.
i) Recovery.
j) Final measurements*.

Impact, spring hammer: Test Eg - IEC 68-2-63 (1991)

1 INTRODUCTION

The object of this test is to determine the ability of a specimen to withstand specified severities of impact, principally to demonstrate mechanical robustness when assessing the safety of a specimen, in particular household and similar appliances, accessories and similar items.

2 GENERAL DESCRIPTION

The spring-operated impact (spring hammer) hand-held test apparatus described in the standard is used to apply a prescribed number of impacts, defined by their impact energy, as the prescribed location(s) on the specimen. The relevant specification shall state whether the specimen is required to operate during impact and if functional monitoring is required.

As prescribed by the relevant specification, the specimen is mounted by its normal means on a rigid plane support or is placed against a rigid plane support. The relevant specification shall also state any requirements for securing bases, covers and similar components before the specimen is subjected to the impacts.

3 SEVERITIES

The severity is defined by the number of impacts, which is five unless otherwise prescribed by the relevant specification, and the impact energy (in joules) selected by the relevant specification from the following:

Impact energy: 0,20; 0,35; 0,50; 0,70; 1,00.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Method of mounting.
b) Impact energy*.
c) Number of impacts, if other than 5.
d) Pre-conditioning.
e) Initial measurements*.
f) Impact locations*.
g) Securing of bases, covers and similar components, when prescribed.
h) Operating mode and functional monitoring*.
i) Acceptance and rejection criteria*.
j) Conditions for recovery, when prescribed.
k) Final measurements*.

VIBRATION (SINUSOIDAL): Test Fc - Publication 68-2-6 (1982) and Amendment No. 1 (1983) and No. 2 (1985).

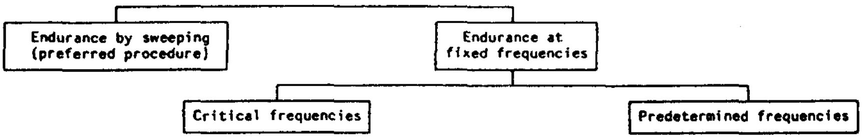
1. INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens which, during transportation or in service, may be subjected to vibration of a harmonic pattern, generated primarily by rotating, pulsating or oscillating forces, such as occur in ships, aircraft, land vehicles, rotorcraft and space applications or are caused by machinery and seismic phenomena.

It may be used to determine the structural integrity of specimens and/or to study their dynamic behaviour.

2. GENERAL DESCRIPTION

The relevant specification is required to state whether or not a vibration response investigation shall be performed and to select the suitable endurance procedure(s) from the following:


Endurance by sweeping (preferred procedure)
Endurance at fixed frequencies
Critical frequencies
Predetermined frequencies

The specimen is subjected to sinusoidal vibration over a specified frequency range, or at discrete frequencies, for a given period of time. In certain circumstances, the relevant specification may require an additional response investigation on completion of the endurance procedure(s).

3. SEVERITIES

The vibration severity is defined by the combination of frequency range, vibration amplitude and duration of endurance (in sweep cycles, for example 10 to 150 to 10 Hz, or time).

Frequency ranges and vibration amplitudes (peak values):

Recommended frequency range Hz
1 - 35
1 - 100
10 - 55
10 - 150
10 - 500
10 - 2000
10 - 5000
55 - 500
55 - 2000
55 - 5000
100 - ˜2000

Recommended vibration amplitudes with a cross-over frequency of							
8 Hz to 9 Hz: lower				57 Hz to 62 Hz: higher			
Note 1		Note 2		Note 1		Note 2	
mm	(in)	m/s²	(g_n)	mm	(in)	m/s²	(g_n)
0.35	(0.014)	0.98	(0.1)	0.035	(0.0014)	4.9	(0.5)
0.75	(0.03)	1.96	(0.2)	0.075	(0.003)	9.8	(1.0)
1.5	(0.06)	4.9	(0.5)	0.15	(0.006)	19.6	(2.0)
3.5	(0.14)	9.8	(1.0)	0.35	(0.014)	49	(5.0)
7.5	(0.30)	19.6	(2.0)	0.75	(0.03)	98	(10)
10	(0.40)	29.4	(3.0)	1.0	(0.04)	147	(15)
15	(0.60)	49	(5.0)	1.5	(0.06)	196	(20)
				2.0	(0.08)	294	(30)
				3.5	(0.14)	490	(50)

Note 1.- Displacement amplitude below the cross-over frequency
Note 2.- Acceleration amplitude above the cross-over frequency

Recommended vibration displacement amplitudes applicable only for frequency ranges with *an upper frequency* of 10 Hz	
Displacement amplitude	
mm	(in)
10	(0.40)
35	(1.4)
75	(3.0)
100	(4.0)

Duration of endurance

a) Endurance by sweeping. The duration of the endurance in each axis shall be specified as a number of sweep cycles chosen from the following values: 1, 2, 5, 10, 50, 100.

b) Endurance at critical frequencies. The duration of the endurance in each appropriate axis at each frequency found during the vibration response investigation shall be specified from the following values: 10 min, 30 min, 90 min, 10 h.

c) Endurance at predetermined frequencies. The duration shall have an upper limit of 10^7 reversals for each stated combination of frequency and axis.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention should be paid to the items marked with an asterisk (*) where this information is always required.

a) Measuring points.
b) Transverse motion.
c) Distortion.
d) Derivation of control signal.
e) Tolerances at check points.
f) Mounting of specimen(s).
g) Frequency range.*
h) Vibration amplitude.*
i) Special cross-over frequency.
j) Type and duration of endurance.*
k) Pre-conditioning.
l) Initial measurements.*
m) Axes of vibration.
n) Force limitation.
o) Test stages to be performed and sequence.*
p) Functioning and functional checks.*
q) Action to be taken after the vibration response investigation.
r) Action to be taken if a change of response frequency is found when a final response investigation is performed.
s) Predetermined frequencies.
t) Conditioning at the resonance frequencies of the specimen on its isolators.
u) Final measurements.*

Fd
Fda
Fdb
Fdc

RANDOM VIBRATION WIDE BAND -	GENERAL REQUIREMENTS:	Test Fd - Publication 68-2-34 (1973) and Amendment No. 1 (1983).
	REPRODUCIBILITY HIGH:	Test Fda - Publication 68-2-35 (1973) and Amendment No. 1 (1983).
	REPRODUCIBILITY MEDIUM:	Test Fdb - Publication 68-2-36 (1973) and Amendment No. 1 (1983).
	REPRODUCIBILITY LOW:	Test Fdc - Publication 68-2-37 (1973) and Amendment No. 1 (1983).

1. INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens when subjected to conditions involving vibration of a stochastic nature.

2. GENERAL DESCRIPTION

The word "reproducibility" is here intended to describe the achievement of similar results when the test is run at different locations by different people. It is important that the writer of the relevant specification does not select a reproducibility higher than necessary for the proposed application of the specimen. Reproducibility High should be called for only when it is absolutely essential.

The relevant specification is required to state the appropriate reproducibility.

If called for by the relevant specification, the wide band random vibration test includes an initial and final resonance search using sinusoidal vibration. For Reproducibility High and Reproducibility Medium the specimen will also be subjected to sinusoidal vibration for frequency response measurements.

3. SEVERITIES

The vibration severity is defined by the combination of frequency range, acceleration spectral density (A.S.D.) level and duration of conditioning (from Publication 68-2-34).

Frequency range:
20 Hz - 150 Hz
20 Hz - 500 Hz
20 Hz - 2000 Hz
20 Hz - 5000 Hz

A.S.D. levels (g^2/Hz):
0.0005
0.001
0.002
0.005
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10

Total duration of conditioning (to be equally divided between the specified directions): 30 s, 90 s, 3 min, 9 min, 30 min, 90 min, 3 h, 9 h, 30 h.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention should be paid to the items marked with an asterisk (*) where this information is always required.

a) to e) Methods of mounting the specimen (including magnetic interference, temperature and gravitational effects, isolator characteristics and supplementary tests).
f) Reference and control points.
g) Frequency range.*
h) A.S.D. levels.*
i) Duration of conditioning.*
j) Reproducibility.*
k) Resonance searches.
l) Acceleration limit for frequency response measurements.
m) Initial measurements.*
n) Functioning during conditioning.*
o) Final measurements.*

VIBRATION - Sine-beat method: Test Fe - IEC 68-2-59 (1990)

1 INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens which may be subjected to short-duration pulsating or oscillating forces, for example seismic or explosive phenomena or vibration in machinery.

It may be used to determine the mechanical robustness of specimens and/or to study their dynamic behaviour.

2 GENERAL DESCRIPTION

The relevant specification is required to state whether or not a vibration response investigation with sinusoidal vibration shall be performed to determine the critical frequencies.

The specimen is subjected to a basic motion which is a sine-beat function of time and is excited in each of the three preferred test axes, unless otherwise prescribed by the relevant specification.

3 SEVERITIES

The severity is defined by the combination of test frequency range, test level, number of cycles in the sine beat and the number of sine beats.

Test frequencies and test frequency range: The test frequencies are critical fequencies determined by the vibration response investigation, any other predetermined frequencies, or both. If no critical frequencies are identified and the relevant specification does not state how to select the test frequencies, the test is carried out at frequencies in steps not greater than one-half octave over a range with lower and upper frequencies selected from values in the table below:

Lower frequency Hz
0,1
1
5
10

Upper frequency Hz
10
20
35
55
100

Recommended test frequency range Hz
0,1 to 10
1 to 35
1 to 100
5 to 35
10 to 100

Test level: The value of each test level shall be prescribed by the relevant specification. Below the crossover frequency, peak values are specified at constant displacement and, above it, at constant acceleration. Recommended values are given in the table below for the different chosen crossover frequencies of 0,8 Hz, 1,6 Hz and 8 Hz.

Displacement levels below the crossover frequency of			Acceleration levels above the crossover frequency of		
0,8 Hz	1,6 Hz	8 Hz	0,8 Hz	1,6 Hz	8 Hz
mm	mm	mm	mm/s²	mm/s²	mm/s²
40	10	0,4	1	1	1
80	20	0,8	2	2	2
120	30	1,2	3	3	3
200	50	2,0	5	5	5
	100	4,0		10	10
	200	8,0		20	20
		12,0			30
		20,0			50

Number of cycles within the sine beat: The number of cycles within the sine beat shall be selected by the relevant specification from the following series: 3, 5, 10, 20.

Number of sine beats: The number of sine beats shall be selected by the relevant specification from the following series: 1, 2, 5, 10, 20, 50, ...

Low-cycle high-stress fatigue effects: The relevant specification may prescribe the required number of high-stress cycles, each resulting in a greater than specified value of stress.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Fixing points*.
b) Transverse motion.
c) Rotational motion.
d) Measuring points.
e) Acceleration distortion.
f) Vibration amplitude tolerances.
g) Mounting of the specimen*.
h) Test frequencies*.
i) Test frequency range*.
j) Test level*.
k) Number of cycles in the sine beat*.
l) Number of sine beats*.
m) Number of high-stress cycles.
n) Pre-conditioning.
o) Initial measurements*.
p) Preferred testing axes.
q) Driving force limitation.
r) Vibration response investigation.
s) Performance and functional check.
t) Single-axis or biaxial conditioning*.
u) Intermediate measurements.
v) Recovery.
w) Final measurements (and acceptance or rejection criteria)*.

VIBRATION - Time-history method: Test Ff - IEC 68-2-57 (1989)

1 INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens which may be subjected to short-duration random type dynamic forces, for example earthquakes, explosions and some phases of transportation.

It may be used to determine the mechanical robustness of specimens and/or to study their dynamic behaviour.

2 GENERAL DESCRIPTION

The relevant specification is required to state whether or not a vibration response investigation with sinusoidal vibration shall be performed to determine the critical frequencies and, when required, the damping ratio.

The specimen is subjected to either (a) a natural time-history or (b) a synthesized time-history generated from frequencies included within the specified range. In certain circumstances, the relevant specification may require an additional response investigation on completion of the time-history conditioning.

3 SEVERITIES

The severity is defined by the combination of test frequency range, required response spectrum, number and duration of time-histories and, where applicable, number of high-stress response cycles.

Recommended test frequency ranges:

Recommended test frequency ranges Hz	
from 0,1 to 10	from 10 to 100
from 1 to 35	from 10 to 500
from 1 to 100	from 10 to 2 000
from 5 to 35	from 55 to 2 000

Required response spectrum: The relevant specification shall state its level and shape, including the value of zero period acceleration, together with the specimen axes along which the spectra are applied when they are not identical for all the axes.

Number of time-histories: The relevant specification shall state the number for each test axis, selected, unless otherwise specified, from the series: ... 1, 2, 5, 10, 20, 50, ...

Duration of each time-history: The relevant specification shall prescribe the duration, selected from the recommended series: ... 1, 2, 5, 10, 20, 50 ... (seconds).

Duration of strong part of time-history: Except where precluded by requirements for the number of high-stress cycles, and unless otherwise specified by the relevant specification, this duration shall be selected from the following percentages of the total duration: 25%, 50%, 75%.

Number of high-stress cycles: The relevant specification may state the number of high-stress cycles leading to values of stress greater than a specified value. The number of high-stress cycles, unless otherwise prescribed, shall be selected from the series ... 4, 8, 16, 32 ... with alternate positive and negative cycles approximately equally distributed. The values, expressed as a percentage of the required response spectrum value at specific critical frequencies located in the strong part of the spectrum, shall be selected from: 50%, 70% (preferred), 90%.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Fixing points*.
b) Transverse motion.
c) Rotational motion.
d) Measuring points.
e) Acceleration distortion.
f) Vibration amplitude tolerances.
g) Damping ratio.
h) Mounting of the specimen*.
i) Test frequency range*.
j) Required response spectrum*
k) Number of time-histories*.
l) Duration of time-history*
m) Duration of strong part of time-history
n) Number of high-stress cycles.
o) Pre-conditioning.
p) Initial measurements*.
q) Preferred testing axes.
r) Driving force limitation.
s) Vibration response investigation.
t) Performance and functional check.
u) Single axis, biaxial or triaxial conditioning*
v) Intermediate measurements.
w) Recovery.
x) Final measurements (and acceptance or rejection criteria)*

Vibration, acoustically induced: Test Fg – Publication 68-2-65 (1993)

1 INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens which may be subjected to high sound pressure levels in an acoustic noise field generated, for example, by jet engines and other aircraft propulsion system, rocket motors or high-powered gas circulators.

2 GENERAL DESCRIPTION

The relevant specification is required to state the type of test facility to be used, the number and location of check-points and the method for controlling the test spectrum. The specimen is subjected to an overall sound-pressure level for a selected exposure time. The relevant specification may permit accelerated testing.

3 SEVERITIES

The severity is defined by the combination of overall sound pressure level, spectrum shape and duration of exposure. The relevant specification shall prescribe:

- the overall sound pressure level and the duration of exposure, chosen from the table given below:

Overall sound pressure level (dB)	Duration of exposure (min)
120 ± 1	60
130 ± 1	60
140 ± 1	30
150 ± 1	30
160 ± 1	30
170 ± 1	2

- the spectrum shape, selected from the three figures shown in the main test document IEC 68-2-65.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Filter bandwidths*
b) Type of facility*
c) Mounting*
d) Instrumentation transducers
e) Location and number of check points*
f) Third or octave band analysis*
g) Spectrum shape*
h) Analysis integration time*
i) Maximum allowable variation in band level
j) Spectrum for third-octave band analysis
k) OASPL*
l) Minimum duration of exposure*
m) Pre-conditioning
n) Initial measurements*
o) Procedure for accelerated testing if required
p) Intermediate measurements
q) Recovery
r) Final measurements*
s) Acceptance and rejection criteria*

Vibration, Broad-band random (digital control)): Test Fh – IEC 68-2-64 (1993).

1 INTRODUCTION

The object of this test is to determine mechanical weakness and/or degradation of specimens when subjected to conditions involving vibration of a stochastic nature resulting from transportation or operational environments, for example, in aircraft, space vehicles and land vehicles, where the test laboratory control is based on digital methods.

2 GENERAL DESCRIPTION

The relevant specification is required to select from two standard test methods. Method 1 normally uses only random vibration. Method 2 uses a vibration response investigation prior to the random vibration, as an integral part of the procedure; this ensures greater reproducibility.

If called for by the relevant specification, vibration response investigations before, or before and after, the random vibration are included in method 1. The relevant specification may also require such a response investigation after the random vibration in method 2.

For either method, the specimen is subjected to broad-band vibration at a severity stated in the relevant specification.

3 SEVERITIES

The severity is defined by the combination of frequency range, acceleration spectral density value and shape, and the duration of testing. It shall be selected by the relevant specification from those given below.

Test frequency range	
f_1 Hz	f_2 Hz
1	100
5	500
20	2 000
50	5 000

Acceleration spectral density value in $(m/s^2)^2/Hz$: 0,05; 0,1; 0,5; 1,0; 5,0; 10,0; 50,0; 100,0.

Acceleration spectral density shape: The shape shall normally be as shown in the main test document IEC 68-2-64. In special cases, the relevant specification may prescribe an alternative shape with, wherever possible, the different acceleration spectral density values and their corresponding frequencies chosen from the main test document.

Duration of testing in each axis: 1; 3; 10; 30; 100; 300 minutes.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Initial vibration response investigation, method 1 (sinusoidal or random excitation).
b) Vibration response investigation using sinusoidal or random excitation, method 2.*
c) Final vibration response investigation, method 1 and method 2.
d) Fixing points.*
e) Transverse motion.
f) Crest factor.*
g) Vibration tolerances.
h) Permitted bias error (for method 2).*
i) Mounting.
j) Test frequency range.*
k) Acceleration spectral density value.*
l) Shape of acceleration spectral density curve.
m) Duration of exposure.*
n) Preconditioning.
o) Initial measurements.*
p) Method 1 or method 2.*
q) Multipoint control.
r) Testing axes and order of testing.
s) Response points, method 2.
t) Multiple measurements of acceleration spectral density.
u) Intermediate measurements.
v) Recovery.
w) Final measurements and acceptance criteria.*

ACCELERATION, STEADY STATE: Test Ga - Publication 68-2-7 (1983) and Amendment No. 1 (1986).

1. INTRODUCTION

The object of this test is to determine the structural suitability and performance of specimens when subjected to forces produced by steady acceleration environments such as occur in moving vehicles, especially flying vehicles, rotating parts and projectiles and to provide a test of structural integrity for certain components.

2. GENERAL DESCRIPTION

For the purpose of this test the specimen is normally mounted on a centrifuge and is subjected to prescribed values of peak acceleration in both senses of each of its major axes. These values will be dependent on whether the specimen has to operate in or to survive the environment.

3. SEVERITIES

Acceleration m/s^2
30
50
100
200
500
1 000
2 000
5 000
10 000
20 000
50 000
100 000
200 000
300 000
500 000

Note.- This note is included for the benefit of those who might still wish to give values of acceleration in terms of g_n or the deprecated g . g_n is defined as the standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude. For the purposes of this publication, the value of g_n is rounded up to the nearest unity, that is 10 m/s^2.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Type of test apparatus.
b) }
c) } Methods of mounting the specimen.
d) Acceleration level(s).
e) Axes and direction of acceleration.
f) Initial measurements.
g) Duration of conditioning.
h) Conditions of functioning or survival.
i) Order of checks.
j) Final measurements.

MOULD GROWTH: Test J - IEC 68-2-10 (1988)

1 INTRODUCTION

The object of this test is to investigate unforeseen causes of deterioration in assembled specimens, whether constructed from mould-resistant materials or not, by the application of test variant 1 and/or test variant 2 using the required severity given in the relevant specification.

2 GENERAL DESCRIPTION

a) Test variant 1: by assessing the extent of mould growth after 28 days' incubation and any physical damage caused thereby and, if required by the relevant specification, by checking the effect on functioning of the specimen after incubation extended to a total of 84 days.

b) Test variant 2: by assessing the extent of mould growth after 28 days' incubation following quasi-contamination with nutrients and any physical damage caused thereby, and by checking the effect on the functioning of the specimen.

Cultures or spores

N°	Name	Strain	Typical culture (for guidance only)	Nature
1	*Aspergillus niger*	V. Tieghem	ATCC, 6275	Grows profusely on many materials and is resistant to copper salts
2	*Aspergillus terreus*	Thom.	PQMD, 82 j	Attacks plastic materials
3	*Aureobasidium pullulans*	(De Barry) Arnaud	ATCC, 9348	Attacks paints and lacquers
4	*Poecilomyces variotii*	Bainier	IAM, 5001	Attacks plastics and leather
5	*Penicillium funiculosum,*	Thom.	IAM, 7013	Attacks many materials especially textiles
6	*Penicillium ochrochloron*	Biourge	ATCC, 9112	Resistant to copper salts and attacks plastics and textiles
7	*Scopulariopsis brevicaulis*	(Sacc.) Bain Var. Glabra Thom.	IAM, 5146	Attacks rubber
8	*Trichoderma viride*	Pers.Ex.Fr	IAM, 5061	Attacks cellulose textiles and plastics

3 SEVERITIES

The test severity for each test variant is determined by the duration of the test.

Variant 1: Two severities are specified: 28 days and 84 days.
Variant 2: One severity is specified: 28 days.

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Test variant 1 or 2.
b) Severity: duration of test.
c) Electrical and mechanical measurements prior to conditioning (only if performance deterioration is to be determined).
d) Pre-conditioning.
e) Conditioning.
f) Electrical and mechanical measurements after exposure (only if performance deterioration is to be determined).
g) Whether the specimens are to be examined, checked and/or photographed.
h) Whether electrical and mechanical measurements after exposure, where these are required, are to be made while damp, or after recovery, or both.
i) Checks to be made after recovery.

SALT MIST: Test Ka - Publication 68-2-11 (1981).

1. INTRODUCTION

The object of this test is to compare the resistance to deterioration from salt mist of specimens of similar construction.

It is useful for evaluating the quality and the uniformity of protective coatings.

The following restrictions shall be taken into account:

a) the test is unsuitable as a general salt corrosion test;

b) it is also considered to be unsuitable for the evaluation of individual specimens intended for use in salt-laden atmospheres.

For equipment and components, Test Kb is considered to provide more realistic conditions and to provide means of assessment of individual items. If however, for particular circumstances, the relevant specification requires that Test Ka be applied to individual specimens for qualification purposes, then the specimens should be tested as part of the overall assembly or equipment in which they are to be used and be complete with any protection devices (cases, covers, shields, etc.), as in practice.

2. GENERAL DESCRIPTION

Samples shall be exposed to a salt mist environment within the test chamber maintained at a temperature of 35 °C. The solution for producing the salt mist shall be prepared by dissolving sodium chloride (NaCl) in water.

3. SEVERITIES

The relevant specification shall prescribe one of the following durations: 16 h, 24 h, 48 h, 96 h, 168 h, 336 h or 672 h.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Initial measurements.
b) Pre-conditioning.
c) Position of the specimens during the test.
d) Severity.
e) Recovery.
f) Final measurements.

SALT MIST, CYCLIC: Test Kb - Publication 68-2-52 (1984).

See also: Publication 355: An Appraisal of the Problems of Accelerated Testing for Atmospheric Corrosion (1971).

1. INTRODUCTION

This test is intended for application to components or equipment designed to withstand a salt laden atmosphere. Salt can degrade the performance of parts manufactured using metallic and/or non-metallic meterials.

Apart from the corrosive effects, this test may be used to indicate deterioration of some non-metallic materials by assimilation of salts. In this test the period of spraying with the relevant salt solution is sufficient to wet the specimen thoroughly and because this wetting is repeated after intervals of storage under humid conditions it goes some way to reproducing the effects of a natural environment.

2. GENERAL DESCRIPTION

This test procedure is separated into a specified number of periods of spraying by a salt mist at a temperature between 15 °C and 35 °C, each followed by storage under humid conditions at 40 °C, 93% relative humidity. The test is conducted on specimens under conditions of non-heat dissipation.

The solution for producing the salt mist is normally prepared by dissolving sodium chloride (NaCl) in water but another salt solution may be prescribed by the relevant specification.

3. SEVERITIES

Severity (1): four spraying periods, each of 2 h, with storage of seven days after each.

Severity (2): three spraying periods, each of 2 h, with a storage between 20 h and 22 h after each.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Salt solution.
b) Initial measurements.
c) Pre-conditioning.
d) Severity.
e) Recovery.
f) Final measurements.

SULPHUR DIOXIDE TEST FOR CONTACTS AND CONNECTIONS: Test Kc - Publication 68-2-42 (1982).
HYDROGEN SULPHIDE TEST FOR CONTACTS AND CONNECTIONS: Test Kd - Publication 68-2-43 (1976).

See also: Publication 68-2-49: Guidance to Test Kc (1983), Publication 68-2-46: Guidance to Test Kd (1982) and Publication 355: An Appraisal of the Problems of Accelerated Testing for Atmospheric Corrosion (1971).

1. INTRODUCTION

These tests are particularly suitable for giving information on a comparative basis. They are not suitable as general corrosion tests as they may not predict the behaviour of contacts and connections in industrial atmospheres.

The principal criterion of assessment will be the change in contact resistance caused by exposure to the test atmosphere.

Test Kc (SO_2) is intended to provide accelerated means to assess the corrosive effects of atmospheres polluted with sulphur dioxide on contacts and connections.

The object of this test is to determine the influence of atmospheres containing sulphur dioxide on the contact properties of precious metal or precious-metal-covered contacts excluding contacts consisting of silver and some of its alloys and to check wrapped or crimped connections with regard to their tightness or effectiveness.

Test Kd (H_2S) is intended to provide accelerated means to assess the effects of the tarnishing of silver and silver alloys used for contacts and connections.

The object of this test is to determine the influence of atmospheres containing hydrogen sulphide on the contact properties of contacts made of silver or silver alloy, silver protected with another layer, other metals covered with silver or silver alloy and to check wrapped or crimped connections, made of the same materials as mentioned above, with regard to their tightness or effectiveness.

2. GENERAL DESCRIPTION

Prior to the commencement of the test, it shall be established by suitable measurements that stable conditions for the concentration of sulphur dioxide or hydrogen sulphide, temperature and relative humidity have been achieved.

Specimens shall be exposed with contacts open and/or closed as prescribed in the relevant specification.

The loading or functioning of the specimens should be permitted when specified in the relevant specification.

The composition of the atmosphere within the test chamber shall satisfy the following conditions:

Sulphur dioxide:	25 parts per million (vol/vol) or
hydrogen sulphide:	10 to 15 parts per million (vol/vol)
temperature:	25 °C
relative humidity:	75%

The relative humidity shall be held as close as possible to 75% but shall in no case exceed 80% nor fall below 70%.

3. SEVERITIES

The specimens shall be continuously exposed to the conditioning atmosphere for 4, 10 or 21 days as required by the relevant specification.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Measurements, checks and mechanical endurance to be made prior to the test.
b) State of the contacts during the test, that is mated (closed) or unmated (open).
c) Loading or functioning of the specimens if applicable.
d) Severity.
e) Measurements, checks and visual inspection to be made at the end of the test.

LOW AIR PRESSURE: Test M - Publication 68-2-13 (1983).

1. INTRODUCTION

The object of this test is to determine the ability of components, equipment or other articles to be stored or used under low air pressure conditions.

2. GENERAL DESCRIPTION

The chamber shall be within the temperature range specified by the standard atmospheric conditions for testing.

For non-operational tests the specimen is introduced into the chamber in an unpacked, switched-off, "ready for use" state, in its normal position or as otherwise specified.

The pressure within the chamber is then to be reduced to the value appropriate to the severity. The relevant specification may limit the rate of change of pressure to not more than 10 kPa/min if necessary.

When operational tests are required, the specimen shall be switched on or be electrically loaded. Checks are made to ascertain whether the specimen is capable of functioning in accordance with the relevant specification. The specimen may remain under operating conditions for the specified duration, or be switched off as prescribed in the relevant specification.

If required by the relevant specification, intermediate measurements shall be performed.

For heat-dissipating specimens the relevant specification may require that the specimen is switched on and adequate time allowed for it to reach thermal stability before or after the air pressure is reduced and functional tests and/or measurements are made.

The air pressure shall be maintained for the specified duration.

The air pressure shall be restored to normal. The relevant specification may limit the rate of change of pressure to not more than 10 kPa/min if necessary.

3. SEVERITIES

Air pressure		Approximate altitude above sea level (from ISO Standard 2533)
kPa	mbar	m
1	10	31 200
2	20	26 600
4	40	22 100
8	80	17 600
15	150	13 600
25	250	10 400
40	400	7 200
55	550	4 850
70	700	3 000
84	840	see note 2

Notes 1. - Altitudes up to 1000 m are covered by the standard air pressure of 86 kPa to 106 kPa.

2. - Applicable when it is required to test equipment at the lower limit of the air pressure value of the standard atmospheric condition for testing.

The relevant specification should state the air pressure and select one of the following durations: 5 min, 30 min, 2 h, 4 h or 16 h.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Pre-conditioning.
b) Initial measurements.
c) State of specimen during conditioning.
d) Severity.
e) Restriction to be applied to rate of change of pressure.
f) Checks, temperature stability, measurements and/or loading during the conditioning period.
g) Recovery.
h) Final measurements.

CHANGE OF TEMPERATURE: Test N - Publication 68-2-14 (1984) and Amendment No. 1 (1986).

See also: Publication 68-2-33: Guidance on change of temperature tests (1971).

1. INTRODUCTION

Change of temperature tests are intended to determine the effect on the specimen of a change of temperature or a succession of changes of temperature. They are not intended to show effects which are due only to the high or low temperature. For these effects, the dry heat test or cold test should be used.

This publication contains three tests:

Test Na: Rapid change of temperature, with prescribed time of transition.
Test Nb: Change of temperature, with specified rate of change.
Test Nc: Rapid change of temperature, two-fluid-bath method.

2. GENERAL DESCRIPTION

The major differences between the three tests are:

Na: The specimens to be tested are moved from one chamber to the other, the resulting temperature shock effect is moderate. The transfer may be manual or automatic.
Nb: The specimens remain in the same chamber, the temperature of which is changed gradually from low to high temperature.
Nc: Using two fluid baths the temperature shock is severe and the method is particularly suitable to test glass-metal seals and similar specimens.

3. SEVERITIES

		Test Na	Test Nb	Test Nc
Temperature	T_A	Lower category temperature or relevant specification	Lower category temperature or relevant specification	Liquid at lower category temperature
	T_B	Upper category temperature or relevant specification	Upper category temperature or relevant specification	Liquid at upper category temperature
Exposure time t_1		10 min, 30 min 1 h, 2 h or 3 h	10 min, 30 min, 1 h, 2 h or 3 h	$5 \text{ min} \le t_1 \le 20 \text{ min}$ $15 \text{ s} \le t_1 \le 5 \text{ min}$
Change-over time t_2		$2 \text{ min} \le t_2 \le 3 \text{ min}$ $t_2 < 30 \text{ s}$ (automatic transfer)	-	8 s or 2 s
Rate of change of temperature		-	1 °C/min 3 °C/min 5 °C/min or relevant specification	-
Number of cycles		5 or relevant specification	2 or relevant specification	10 or relevant specification

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Test Na

a) Mounting or supporting of the test specimen if other than specified.
b) Low temperature T_A/high temperature T_B.
c) Number of cycles, if other than five.
d) Initial measurements.
e) State of the specimen when introduced into the chamber.
f) Exposure time t_1, if other than 3 h.
g) If automatic transfer test equipment with a change-over period of less than 30 s is allowed.
h) Duration extension.
i) Recovery.
j) Final measurements.

Test Nb

a) Mounting or supporting of the test specimen if other than prescribed.
b) Low temperature T_A/high temperature T_B.
c) Rate of change of temperature.
d) Number of cycles, if other than two.
e) Initial measurements.
f) State of the specimen when introduced into the chamber.
g) Exposure time t_1, if other than 3 h.
h) Electrical and mechanical checks during conditioning and the period after which they shall be carried out.
i) Recovery.
j) Final measurements.

Test Nc

a) Duration: groups of parameters 1 or 2, and value of t_1.
b) Number of cycles, if other than ten.
c) Temperature of cold bath, if other than 0 °C.
d) Temperature of hot bath, if other than +100 °C.
e) The liquids to be used.
f) Initial measurements.
g) Recovery.
h) Final measurements.

SEALING: Test Q - IEC 68-2-17 (1978) and Amendment 4 (1991) including Amendments 1, 2 and 3

1 INTRODUCTION

The diagram below indicates the interrelation between the various sealing tests in Test Q of IEC 68. Other tests in this category are rain and water tests which is included as Test R.

2 TESTS

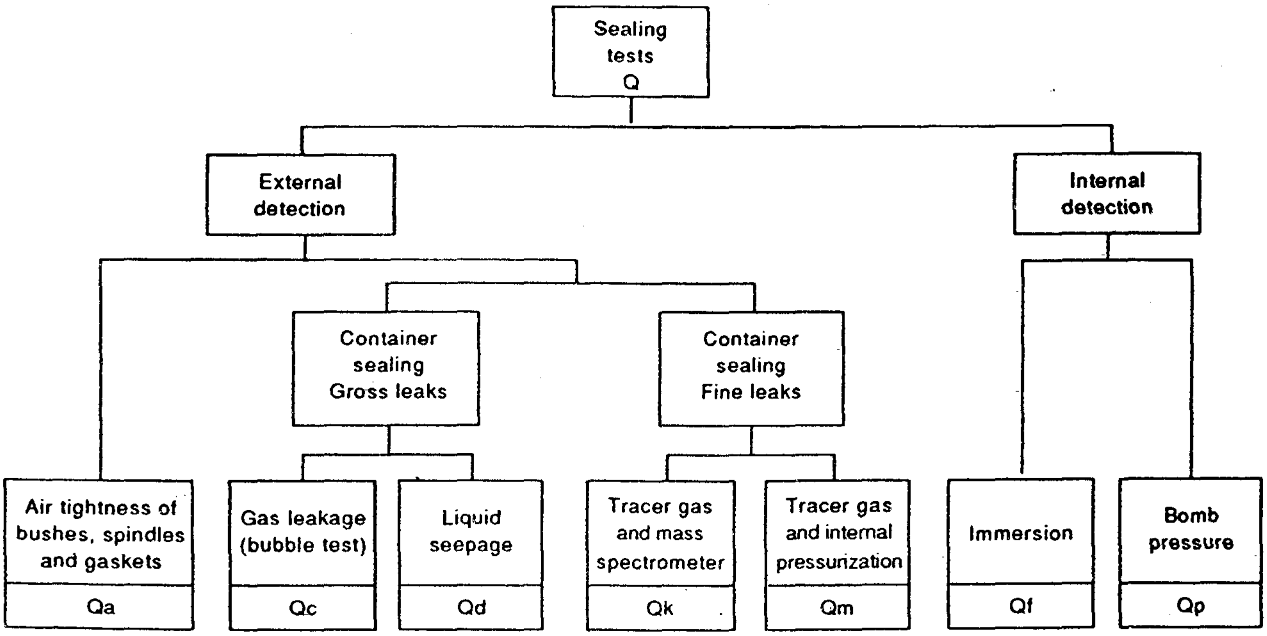
The family tree of tests is shown below.

Test Q may be subdivided in the following two sub-groups, distinguished by their detection methods:

- internal detection which measures changes of electrical characteristics produced by the test medium (liquid or gas) introduced into the specimens through the leak;
- external detection whereby the escape of the test medium through the leak is observed.

The two tests for internal detection, Qf and Ql, are very similar. They are effective for certain components, for example, plastic film capacitors; they are not recommended, however, for most semiconductor components because electrical changes may become effective only after a long time (for instance, after the test is terminated) owing to the passivation of the surface of the semiconductor.

The tests for external detection are further subdivided according to their application. Test Qa is a bubble test which is used to determine the air tightness of bushings, spindles and gaskets. The other Tests, Qc, Qd, Qk and Qm, are used to determine leaks in small containers (metallic cases, housings, etc.); Test Qc is a bubble test, again including three methods with different sensitivities. Test Qk and Test Qm are the most sensitive of this series. Test Qk uses helium and a mass spectrometer. Test Qm defines methods for measuring fine leaks by accumulation or by simply detecting them by probing using a tracer gas with internal pressurization, for example sulphur hexafluoride or other halogenous gas. Test Qd is a liquid seepage test which may be applied to specimens filled during manufacture with a liquid or a product becoming liquid at the test temperature.


Sealing tests Q
External detection
Internal detection
Container sealing Gross leaks
Container sealing Fine leaks
Air tightness of bushes, spindles and gaskets
Qa
Gas leakage (bubble test)
Qc
Liquid seepage
Qd
Tracer gas and mass spectrometer
Qk
Tracer gas and internal pressurization
Qm
Immersion
Qf
Bomb pressure
Qp

SEALING OF BUSHES, SPINDLES AND GASKETS: Test Qa - Publication 68-2-17 (1978) and Amendment No. 1 (1985).

1. INTRODUCTION

The object of this test is to determine the effectiveness of seals of bushes, spindles and similar features.

2. GENERAL DESCRIPTION

The specimen is mounted on the lid of a pressurized test chamber which is submerged in a liquid. If the specimen leaks, the air escaping is collected. The amount of air collected per unit time is a measure of the air leakage.

3. SEVERITIES

Unless otherwise specified, an air pressure difference, as specified below, shall be applied across each seal or simultaneously across a group of seals forming an assembly.

Type A: 100 kPa (10 N/cm^2) to 110 kPa (11 N/cm^2) in the direction specified in the relevant specification.

Type B: 100 kPa (10 N/cm^2) to 110 kPa (11 N/cm^2) in each direction.

If a higher pressure is required, it shall be between 340 kPa (34 N/cm^2) and 360 kPa (36 N/cm^2).

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Severity.
b) Direction of application of pressure difference.
c) Mechanical operation during conditioning.
d) Requirements for leakage rate.

CONTAINER SEALING, GAS LEAKAGE: Test Qc - Publication 68-2-17 (1978) and Amendment No. 1 (1985).

1. INTRODUCTION

The object of this test is to determine the effectiveness of seals of specimens having an included gas-filled space (for example specimens not completely filled with impregnant).

2. GENERAL DESCRIPTION

The detection of gross leaks is achieved by submerging the specimen in a suitable liquid under controlled conditions and by observing bubbles emanating from the specimen surface.

A positive internal pressure within the specimen is generated, by one of the following test methods:

Test method 1 (sensitivity: 10 Pa.cm^3/s (10^{-4} bar.cm^3/s))

The test is conducted in a vacuum environment, thereby increasing the pressure differential across the seals of the specimen.

The test liquid shall have the following characteristics:

kinematic viscosity at 20 °C: 25.10^{-6} m^2/s (25 cSt);
kinematic viscosity at 50 °C: 9.10^{-6} m^2/s (9 cSt);
ambient vapour pressure: <10 Pa (10^{-4} bar).

A suitable liquid is oil. It should be degassed.

Test method 2 (sensitivity: 100 Pa. cm^3/s (10^{-3} bar. cm^3/s))

The specimen, which shall be at a temperature between 15 °C and 35 °C, is immersed in a test liquid maintained at an elevated temperature.

Water with a wetting agent can be used for test temperatures lower than 90 °C. For higher test temperatures suitable liquids should have a kinematic viscosity of the order of 0.3×10^{-6} m^2/s (0.3 cSt) at the test temperature. In the latter case, commonly used liquids are fluorocarbons.

Test method 3 (sensitivity: 1 Pa. cm^3/s (10^{-5} bar. cm^3/s))

This involves impregnation of the specimen with a liquid having a boiling point below the test temperature (Step 1), followed by immersion in a test liquid (Step 2).

The impregnation liquid shall have a kinematic viscosity of the order of 0.4×10^{-6} m^2/s (0.4 cSt) at room temperature, a boiling point of approximately 60 °C and a low heat of vaporization at boiling point so as to generate vapour quickly within the specimen when Step 2 is performed. Commonly used liquids are fluorocarbons.

The specimens shall then be pressurized under the following conditions:

Internal cavity volume	Minimum pressure (absolute)	Minimum duration
≤0.1 cm^3	600 kPa (6 bar)	1 h
>0.1 cm^3	300 kPa (3 bar)	2 h

For Step 2 apply Test Method 2, using a temperature of 125 °C unless otherwise specified.

3. SEVERITIES

Not specified.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Test method.
b) Recommended liquid(s).
c) Test Method 1: pressure and time, if not 1 kPa (10 mbar) and 1 min.
d) Test Method 2: liquid temperature, if not 1 °C to 5 °C above the maximum ambient temperature.

e) Test Method 2: immersion duration, if not 10 min.
f) Drying time if different from 3 min.
g) Test Method 3: Step 2 temperature, if different from 125 °C.

CONTAINER SEALING, SEEPAGE OF FILLING LIQUID: Test Qd - Publication 68-2-17 (1978) and Amendment No. 1 (1985).

1. INTRODUCTION

The object of this test is to determine the effectiveness of seals of specimens filled with liquid.

The test may also be used for specimens having a filling which is solid at room temperature but which is liquid at the testing temperature.

2. GENERAL DESCRIPTION

The specimen is examined for seepage of liquid likely to occur when it is brought up to a temperature slightly higher than its maximum ambient temperature of operation.

3. SEVERITIES

A severity is defined as the period of time at which the specimen is maintained at the testing temperature. The relevant specification shall state the applicable severity chosen from the following list:

10 min
1 h
4 h
24 h
48 h

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Test temperature.
b) Severity.
c) Method of detecting seepage.

IMMERSION: Test Qf - Publication 68-2-17 (1978) and Amendment No. 1 (1985).

1. INTRODUCTION

The object of this test is to determine the watertightness of components, equipments or other specimens when subjected to immersion under stated conditions of pressure and time.

2. GENERAL DESCRIPTION

The specimen is submitted to a specified pressure by immersion in a water tank at a specified depth or in a high pressure water chamber. After conditioning the specimen is examined for penetrated water and checked for possible changes of characteristics.

3. SEVERITIES

The specimens shall be subjected to one of the head-of-water values or the corresponding pressure differences given below as required by the relevant specification.

Head of water m	Corresponding pressure difference (at 25 °C) kPa
0.15	1.47
0.40	3.91
1	9.78
1.50	14.7
4	39.1
6	58.7
10	97.8
15	147.0

Preferred durations are 30 min, 2 h, 24 h.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Electrical and mechanical checks prior to conditioning.
b) Pre-conditioning procedure.
c) Position during conditioning.
d) Whether a wetting agent may be used or not.
e) Head of water or pressure difference.
f) Duration of conditioning.
g) Electrical and mechanical checks after recovery.

SEALING TRACER GAS METHOD WITH MASS SPECTROMETER: Test Qk - IEC 68-2-17 (1978) and Amendment 4 (1991)

1 INTRODUCTION

The object of this test is to verify the hermetic sealing of specimens by evaluating the leak rates with a tracer gas, usually helium, and a mass spectrometer.

This can be used for the detection of leak rates smaller than about 1 Pa·cm^3/s (10^{-5} bar·cm^3/s), but for leak rates below about 10^{-3} Pa·cm^3/s (10^{-8} bar·cm^3/s) caution should be exercised in the interpretation of results.

2. GENERAL DESCRIPTION

In *Test method 1*, the specimen, previously carefully cleaned and dried, is impregnated with helium under pressure. After a given time, the leak rate (R) of the specimen under vacuum is measured with a mass spectrometer. The equivalent standard leak rate (L) can be deduced. This method is applicable only when the specimens do not have surfaces (such as braids, joints, organic materials, paints, etc.) likely to impair the results by too high a retention of absorbed tracer gas, unless they have been suitably neutralized before the detection phase.

Test method 2 is similar to test method 1, with the exception of the impregnation phase which is omitted. It is intended for specimens that have been filled, during manufacture, with a mixture containing a large proportion of helium. The test is normally completed within 30 min after package sealing. This test is not suitable for general hermetic seal testing such as that required at the end of other environmental tests.

Test method 3 (jet and pocket method) is intended for specimens to be mounted on bulkheads or panels.

Test method 3 can only be applied to specimens capable of withstanding a fairly high vacuum and not degassing excessively.

Test method 3 consists of exposing one side of the specimen to a vacuum by placing it against a suitable orifice of a vacuum chamber connected to a mass spectrometer. The visible side of the specimen is then covered by a sealed flexible pocket filled with helium (alternative *a)*) or swept by a fine jet of helium (alternative *b)*).

Alternative a): If leaks occur, some of the helium in the pocket is sucked into the vacuum chamber. The size of the fault (but not its location) can be determined from the readings on the mass spectrometer.

Alternative b): Helium is detected by the detector when the helium jet passes over a sealing fault (leak). The location and size of the leak can then be determined from the readings on the mass spectrometer.

3 SEVERITIES

Immersion pressure (absolute) Pa · 10^4 bar	Immersion time (minimum) t minutes	Severity 6 h ($\theta = 2 \cdot 10^4$ s)		Severity 60 h ($\theta = 2 \cdot 10^5$ s)		Severity 600 h ($\theta = 2 \cdot 10^6$ s)		Severity 1 000 h ($\theta = 4 \cdot 10^6$ s)		Equivalent standard leak rate L Pa · cm^3/s (bar · cm^3/s)
		Internal volume V cm^3	Measured leak rate (maximum) R Pa · cm^3/s (bar · cm^3/s)	Internal volume V cm^3	Measured leak rate (maximum) R Pa · cm^3/s (bar · cm^3/s)	Internal volume V cm^3	Measured leak rate (maximum) R Pa · cm^3/s (bar · cm^3/s)	Internal volume V cm^3	Measured leak rate (maximum) R Pa · cm^3/s (bar · cm^3/s)	
2 3 4 5 8	70 45 30 30 20					0,01 to 0,1	10^{-5} (10^{-10})	0,02 to 0,2	10^{-5} (10^{-10})	$5 \cdot 10^{-4}$ to $1,5 \cdot 10^{-3}$ ($5 \cdot 10^{-9}$ to $1,5 \cdot 10^{-8}$)
2 3 4 5 8	70 45 30 30 20			0,01 to 0,1	10^{-3} (10^{-8})	0,1 to 1,0	10^{-4} (10^{-9})	0,2 to 2,0	10^{-4} (10^{-9})	$5 \cdot 10^{-3}$ to $1,5 \cdot 10^{-2}$ ($5 \cdot 10^{-8}$ to $1,5 \cdot 10^{-7}$)
2 3 4 5 8	70 45 30 30 20	0,01 to 0,1	0,1 (10^{-6})	0,1 to 1,0	10^{-2} (10^{-7})	1,0 to 10	10^{-3} (10^{-8})	2,0 to 20	10^{-3} (10^{-8})	0,05 to 0,15 ($5 \cdot 10^{-7}$ to $1,5 \cdot 10^{-6}$)
2 3 4 5 8	240 160 120 90 60	0,1 to 1,0	2 ($2 \cdot 10^{-5}$)	1,0 to 10	0,5 ($5 \cdot 10^{-6}$)	10 to 100	0,05 ($5 \cdot 10^{-7}$)	20 to 200	10^{-2} (10^{-7})	0,5 to 1,5 ($5 \cdot 10^{-6}$ to $1,5 \cdot 10^{-5}$)
2 3 4 5 8	480 320 240 190 120		5 ($5 \cdot 10^{-5}$)		1 (10^{-5})		0,1 (10^{-6})		0,05 ($5 \cdot 10^{-7}$)	0,5 to 1,5 ($5 \cdot 10^{-6}$ to $1,5 \cdot 10^{-5}$)

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Test method

Test method 1

b) Severitys
c) Test parameters
d) Test parameters (special cases)
e) Maximum immersion pressure allowed for the type of device
f) Gross leaks: detection method to be used

Test method 2

g) Time constant
h) Gross leaks: detection method to be used

Test method 3

i) Mounting conditions (if necessary)
j) Alternative *a)* or *b)*
k) Helium pressure
l) Acceptance criteria

BOMB PRESSURE TEST: Test Ql - Publication 68-2-17 (1978) and Amendment No. 1 (1985).

1. INTRODUCTION

The object of this test is to determine the effectiveness of seals of specimens whose electrical characteristics will be affected by penetration of liquid.

Note.- This test is not recommended for use as a 100% inspection.

2. GENERAL DESCRIPTION

This test consists in allowing a liquid to penetrate through a leak to the interior of the specimen. It is commonly known as the bomb pressure test.

The test liquid must possess the property of producing detectable changes in the electrical characteristics of the specimen. Assessment of the leakage is achieved by measuring those specified electrical parameters which are influenced by the penetration of the test liquid (for example a suitable alcohol). Adding colouring agent to the test liquid can show the path of penetration after opening the specimen under test. As it usually requires some time for the penetration of the test liquid to affect the electrical characteristics, repeated measurements, separated by short periods of storage, may be necessary.

The maximum sensitivity is limited to approximately 1 Pa.cm^3/s (10^{-5} bar.cm^3/s). No quantitative information on the leakage rate can be obtained from the test.

3. SEVERITIES

The pressure value and duration shall be prescribed in the relevant specification.

The maximum pressure depends mainly on the construction of the specimen. It should normally not exceed 500 kPa (50 N/cm^2); 250 kPa/cm^2 (25 N/cm^2) is sufficient for a number of applications.

The duration of the conditioning is normally not more than 16 h. In special cases, for example when using lower pressures, the duration may be raised to 24 h.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Measurements prior to conditioning.
b) Type of test liquid.
c) Temperature of the test liquid.
d) Pressure in the test vessel.
e) Duration of conditioning.
f) Cleaning and type of liquid.
g) Duration of recovery.
h) Measurement after recovery.
i) Repeated recovery and repeated measurements.

TRACER GAS SEALING TEST WITH INTERNAL PRESSURIZATION: Test Qm - IEC 68-2-17 (1978) and Amendment 4 (1991)

1 INTRODUCTION

The object of this test is to define methods for measuring fine leaks by accumulation or for detecting them by probing using a tracer gas easily separable from air components, for example sulphur hexafluoride or other halogenous gas.

The test is applicable to any specimen able to withstand internal pressurization. It allows the detection of leakage greater than approximately 10^{-8} Pa · m^{3} · s^{-1} (10^{-7} bar · cm^{3} · s^{-1}).

2 GENERAL DESCRIPTION

The total leakage flow can be determined from a single operation but not, simultaneously, the number of leaks or their location. It is therefore necessary to distinguish "total methods", allowing the measurement of the total leakage flow, from "local methods", allowing the location of individual leaks for rectification if required. For example, the cumulative test is a "total method" while the probing test is a "local method".

Another possibility is an "intermediate method" in which leakage is accumulated (total method) from a part of the specimen (partial localization). This intermediate method is then applied to every part of the specimen.

Test method 1: Cumulative test

The specimen whose sealing is to be assessed is internally pressurized with a tracer gas.

After allowing time for the leak rate to stabilize, the whole specimen (or a part of its surface) is enclosed in a gas-tight sheath in which the gas leaking from any defect accumulates for a measured duration. This collected gas is then measured and the leak rate calculated.

The sensitivity of the test also depends on the capacity of the volume of measurement and on the time interval between the two concentration measurements.

The leak rates measured by this method have an accuracy of the order of ±50 %.

Test method 2: Probing test

The specimen of which any leaks are to be detected is internally pressurized with a tracer gas.

After allowing time for the leak rate to stabilize, the probe of a leak detector is placed near the specimen and moved over its surface. If the concentration of tracer gas reaches the threshold level of the detector, it gives a signal permitting the leak to be localized.

The sensitivity of the test also depends on the speed with which the probe is moved and on the distance at which the end of the probe is to be moved over the surface of the specimen. The speed should not be greater than 10 mm/s at a distance not greater than 5 mm.

3. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Whether leak rate may be estimated using test method 2.
b) Additional pre-conditioning.
c) Method to be used (test method 1 or 2 or "intermediate").
d) Whether specimen is operating or not, etc.
e) Test pressure and time for stabilization of the test gas.
f) Maximum leak rate allowed.

WATER: Test R - IEC 68-2-18 (1989)

1 INTRODUCTION

The primary purpose of water tests is to verify the ability of covers and seals to retain components and equipment in good working order after and, when necessary, under a standardized water dropfield or an immersion.

The diagram below indicates the interrelation between the varous methods of test R and presents other established water tests.

2 TESTS

The water test is structured into three groups.

Ra "Falling drops" which in principle is a test with artificial rain. It is applicable to electrotechnical products which during transportation, storage or in service may be exposed to vertical falling drops, the origin of these being, for example, natural rain, seepage or condensation.

Rb "Impacting water" where high intensity dropfields or water jets impinge upon the test specimen with a certain force and the dropfields may assume any angle towards the test specimen. The test is applicable to electrotechnical products which, during transportation, storage or service, may be subjected to impacting water. The origin for this can be water from cloud-bursts, heavy driving rain, sprinkler systems, spray from wheels, sluicing or breaking seas.

Rc "Immersion" where the test specimen is immersed in water to specified depths or equivalent pressures. It is applicable to electrotechnical products which are designed to be watertigh and, during transportation or in service, may be subjected to partial or complete immersion.

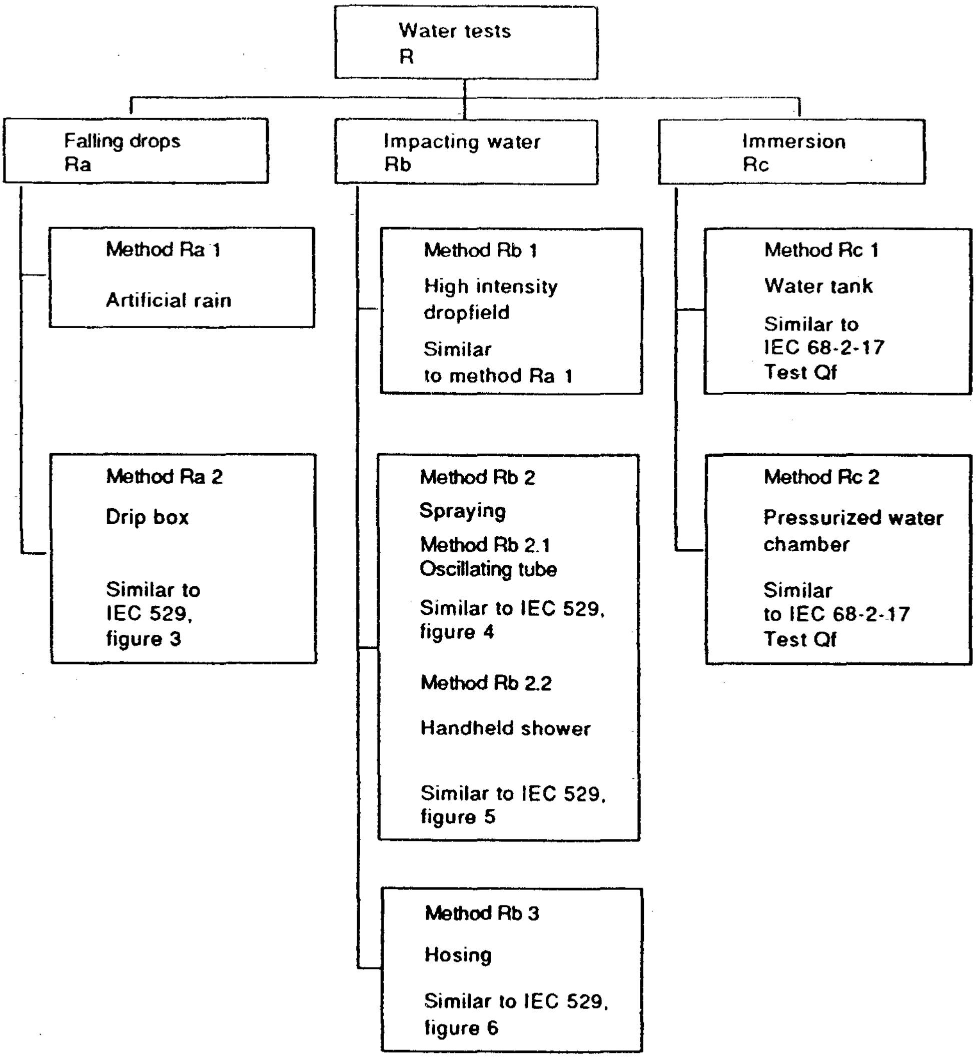


FIGURE 1 - Structuring of test methods

WATER: Test R - IEC 68-2-18 (1989)

1 INTRODUCTION

Test Ra: Falling drops, comprises two test methods.

Method Ra 1: Artificial rain, applicable for electrotechnical products which may be placed outdoors and unprotected from natural rain.

Method Ra 2: Drip box, is applicable for electrotechnical products which normally are protected from natural rain, but may be exposed to falling drops from condensation or leakage from upper surfaces.

The selected test method and severities represent the most severe exposure anticipated for the test item when in ordinary use.

2 GENERAL DESCRIPTION

Method Ra 1: Artificial rain

The test specimen is mounted on an appropriate fixture. It is then subjected to falling water-drops, which simulate natural rain. Fresh tap water is used for the test.

Method Ra 2: Drip box

The test specimen is mounted on an appropriate fixture placed under the drip box. The test specimen is subjected to water-drops, which simulate falling water from condensation leakage.Fresh tap water is used for the test.

3 SEVERITIES

Method Ra 1 – Artificial rain

Intensity R mm/h	Associated dropsize D_{50} mm	Duration min	Spray or tilt angle α°
10 ± 5	1,9 ± 0,2	10	0
100 ± 20	2,9 ± 0,3	30	15
400 ± 50	3,8 ± 0,4	60	30
		120	60
			90

Method Ra 2 – Drip box

Drop falling height m	Tilt angle α°	Duration min
0,2 ± 0,1	0	3
2,0 ± 0,5	15	10
	30	30
	45	60

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Method Ra 1: Artificial rain

a) Severities:
  - tilt angle of specimen,
  - test duration,
  - intensity and associated drop size distribution.

b) Preconditioning.
c) Initial measurements.
d) Mounting of specimen.
e) Speciment position or positions during conditioning.
f) State of the specimen during conditioning.
g) Intermediate measurements.
h) Final measurements.

Method Ra 2: Drip box

a) Severities:
  - drop falling height,
  - tilt angle of specimen,
  - test duration.

b) Preconditioning.
c) Initial measurements.
d) Mounting of specimen.
e) Speciment position or positions during conditioning.
f) State of the specimen during conditioning.
g) Intermediate measurements.
h) Final measurements.

WATER: Test R - IEC 68-2-18 (1989)

1 INTRODUCTION

Test Rb: Impacting water, comprises three test methods.

Method Rb 1: High intensity dropfield, is applicable to electrotechnical products which in tropical areas may be placed outdoors and unprotected from natural rain as cloudburst or heavy driving rain.

Method Rb 2: Oscillating tube and hand-held shower head are applicable for electrotechnical products which may be exposed to water from sprinkler systems or spray from wheels.

Method Rb 3: Hosing is applicable for electrotechnical products which may be exposed to flushing, sluicing or breaking seas.

The selected test method and severities represent the most severe exposure for the test item when in ordinary use.

If method Rb 2 is selected, the oscillating tube should be chosen as test method provided the dimensions and shape of the test specimen are such that the radius of the oscillating tube does not exceed 1,6 m. Where this condition cannot be fulfilled, a hand-held shower head shall be used.

2 GENERAL DESCRIPTION

Method Rb 1: High intensity dropfield

The test specimen is mounted to an appropriate fixture. It is then subjected to high intensity dropfield. Fresh tap water is used for the test.

Method Rb 2: Oscillating tube and hand-held showerhead

Two alternative test variants, the oscillating tube and the hand-held shower, are available for this test. The test specimen is mounted on an appropriate fixture and is subjected to impacting water generated from a semicircular tube or, if the specimen is too large for the oscillating tube variant, a hand-held showerhead should be utilized. Fresh tap water is used for the test.

Method Rb 2-1: Oscillating tube variant

Method Rb 2-2: Hand-held shower variant

This variant is provided for those specimens that are too large for the oscillating tube variant.

Method Rb 3: Hosing

The test specimen is mounted on a fixture. The test specimen is subjected to hosing water which should simulate wheel spray, sluicing or breaking seas. Fresh tap water is used for the test.

3 SEVERITIES

Method Rb 1

Intensity R mm/h	Duration min	Tilt angle α°
1 000 ± 150	10	0
2 000 ± 300	30	15
4 000 ± 600	60	30
		60
		90

Method Rb 2-1

Spray nozzle angle α°	Tube oscillating angle β°	Duration min
60°	± 60°	3
90°	c. ± 180°	10
		30
		60

Nozzle orifice diameter mm	Water flow per nozzle dm³/min	Approximate supply pressure kPa
0,40	0,10 ± 0,005	80
0,80	0,60 ± 0,03	400

Method Rb 2-2

Exposure min/mm²	Minimum test duration min
1	5
3	15
6	30

Method Rb 3: Hosing

Flow rate dm³/min	Approximate pressure supply kPa	Nozzle size min
12,5 ± 1	30	6,3
75 ± 5	1 000	6,3
10 ± 5	100	12,5

Exposure min/m²	Minimum test duration min	Note
0,3	1	**Only for 6,3 mm nozzle and 1 000 kPa**
1	3	
3	10	
10	30	

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Method Rb 1: High intensity dropfield

a) Severities:
  - tilt angle of specimen,
  - test duration,
  - intensity.

b) Preconditioning.
c) Initial measurements.
d) Mounting of specimen.
e) Specimen position or positions during conditioning.
f) State of the specimen during conditioning.
g) Intermediate measurements.
h) Final measurements.

Method Rb 2-1: Oscillating tube variant

a) Severities:
  - spray nozzle angle,
  - water flow rate per nozzle,
  - tube oscillating angle,
  - test duration.

b) Preconditioning.
c) Initial measurements.
d) Conditioning.
e) Intermediate measurements.
f) Final measurements.

Method Rb 2-2: Hand-held shower variant

a) Severities:
  - surface specimen to be sprayed, if not all,
  - use of a shield or not,
  - test duration.

b) Preconditioning.
c) Initial measurements.
d) Conditioning.
e) Intermediate measurements.
f) Final measurements.

Method Rb 3: Hosing

a) Severities:
  - nozzle size,
  - sluicing distance,
  - test duration,
  - distance from the nozzle to the specimen, if differs from 2,5 mm ± 0,5 m.

b) Preconditioning.
c) Initial measurements.
d) Conditioning.
e) Intermediate measurements.
f) Final measurements.

Rc

WATER: Test R - IEC 68-2-18 (1989)

1 INTRODUCTION

Test Rc: immersion, comprises two test methods.

Method Rc 1: Water tank, and Method Rc 2: Pressurized water chamber, are both applicable to electrotechnical products which, during transportation or in service, may be subjected to partial or complete immersion.

2 GENERAL DESCRIPTION

Normally fresh tap-water is used. If, however, a test is to be made in seawater, this shall be noted in the relevant specification together with the characteristics of the seawater.

A water soluble dye such as fluorescein may be added to the water to aid locating and analysing water leaks.

Method Rc 1: Water tank

The test specimen is subjected to a specified pressure by immersion in a water tank at a specified depth.

Method Rc 2: Pressurized water chamber

The test specimen is subjected to a specified pressure by immersion in a pressurized water chamber.

3 SEVERITIES

Method Rc 1 - Water tank

Head of water m	Duration h
0,15	0,5
0,40	2,0
1,00	24,0
2,00	
5,00	

Method Rc 2 - Pressurized water chamber

Overpressure kPa	Equivalent head water m	Duration h
20	2	2
50	5	24
100	10	168
200	20	
500	50	
1 000	100	
2 000	200	
5 000	500	
10 000	1 000	

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Method Rc1: Water tank

a) Seawater.
b) Severities:
  - head of water,
  - test duration,
c) Preconditioning.
d) Initial measurements.
e) Mounting of specimen.
f) State of the specimen during conditioning.
g) Intermediate measurements.
h) Recovery.
i) Final measurements.

Method Rc 2-1: Pressurized water chamber

a) Seawater.
b) Severities:
  - pressure in the chamber,
  - test duration,
c) Preconditioning.
d) Initial measurements.
e) Mounting of specimen.
f) State of the specimen during conditioning.
g) Intermediate measurements.
h) Recovery.
i) Final measurements.

SIMULATED SOLAR RADIATION AT GROUND LEVEL: Test Sa - Publication 68-2-5 (1975).

See also: Publication 68-2-9: Guidance for Solar Radiation Testing (1975) and Amendment No. 1 (1984).

1. INTRODUCTION

The object of this test is to determine the effects (thermal, mechanical, chemical, electrical, etc.) produced on equipment and components as a result of exposure to solar radiation under the conditions experienced at the surface of the earth.

2. GENERAL DESCRIPTION

The specimens are subjected to an irradiance of 1.120 kW/m^2 with the prescribed spectral distribution.

Procedure A

A 24 h cycle, with 8 h irradiation and 16 h darkness, repeated as required. (This gives a total irradiation of 8.96 kWh/m^2 per diurnal cycle, which approximates to the most severe natural conditions.)

Procedure B

A 24 h cycle, with 20 h irradiation and 4 h darkness, repeated as required. (This gives a total irradiation of 22.4 kWh/m^2 per diurnal cycle.)

Procedure C

Continuous irradiation, as required.

3. SEVERITIES

The preferred durations are the following:

a) 3 cycles or days;
b) 10 cycles or days;
c) 56 cycles or days.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Pre-conditioning procedure.
b) Electrical and mechanical checks to be made prior to the test.
c) Description of the substrate and/or the means of support for the specimen(s) under test, attitude of specimen(s), relative position or irradiation measurement plane and direction of incident radiation (if other than vertically downwards is required).
d) Test procedure to be followed (that is whether A, B or C) and object of test.
e) Temperature within the enclosure required during irradiation (whether +40 °C or +55 °C).
f) Maximum permissible air velocity within the enclosure.
g) Associated humidity conditions, if required.
h) Duration of the test.
i) Operation, checks and temperature measurements required during conditioning.
j) Recovery conditions.
k) Electrical and mechanical checks to be made after the test.
l) Any other details.

SOLDERING: Test T - Publication 68-2-20 (1979) and Amendment No. 1 (1986).
SOLDERABILITY OF WIRE AND TAG TERMINATIONS: Test Ta.

See also: Publication 68-2-54 (1985): Test Ta: Soldering - Solderability Testing by the Wetting Balance Method.
Publication 68-2-44 (1979): Guidance on Test T: Soldering.

1. INTRODUCTION

The object of this test is to determine the solderability of the areas on wire and tag terminations that are required to be wetted by solder, and, if required, to determine any de-wetting.

2. GENERAL DESCRIPTION

The standard provides three different test methods:

Method 1: Solder bath at 235 °C.
Method 2: Soldering iron at 350 °C.
Method 3: Solder globule at 235 °C.

Method 1 with suitable changes in times and temperatures is used to determine de-wetting behaviour.

The test method to be used shall be indicated in the relevant specification. The solder bath method is the one which simulates most closely the soldering procedures that are generally used in practice; however, it is not practicable to express the results as a number.

With the solder globule method a specimen of round wire termination bisects a globule of molten solder of a given weight. It is easy to apply and the soldering time is a precise inspection criterion.

A non-activated flux shall be used unless othervise prescribed by the relevant specification.

The soldering iron method may be used in cases where the two other methods are impracticable.

If prescribed by the relevant specification, conditioning is preceded by accelerated ageing. The relevant specification shall indicate one of the following ageing procedures:

Ageing 1a: 1 h steam ageing.
Ageing 1b: 4 h steam ageing.
Ageing 2: 10 days damp heat, steady state condition (Test Ca - Publication 68-2-3).
Ageing 3: 16 h at 155 °C dry heat (Test Ba - Publication 68-2-2).

3. SEVERITIES

Method 1

Temperature of the solder bath: 235 °C
Speed of immersion: 25 mm/s
Immersion time: 2 s
For high thermal capacity components, 5 s, if prescribed by the relevant specification.

Method 2

Bit temperature: 350 °C
Application time: 2 s to 3 s.

The relevant specification shall prescribe the soldering iron to be used, namely:
Size A, bit diameter: 8 mm.
Size B, bit diameter: 3 mm.

Method 3

The maximum value of the soldering time, that is the time elapsing between the moment that the wire bisects the solder globule and that when the solder flows around and covers the wire, shall be prescribed in the relevant specification.

De-wetting

The relevant specification shall prescribe whether this test is required.

Temperature of the solder bath: 260 °C
Speed of immersion: 5 mm/s
Immersion time: 10 s (two periods of 5 s).

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Whether degreasing is required.
b) Initial measurements.
c) Ageing method, if required.
d) Test method.
e) Whether activated flux shall be used.
f) Immersion depth and time if not 2 s (for Method 1).
g) Whether a thermal screen is to be used.
h) Size of soldering iron (A or B).
i) Distance of test area from component body or use of a heat sink.
j) Different test conditions, if required by geometry of termination.
k) Position of the soldering iron.
l) Application time of soldering iron, if not 2 s to 3 s.
m) Soldering time.
n) Whether the de-wetting test is required.
o) Immersion depth (for de-wetting).
p) Final measurements.

SOLDERING: Test Ta- Publication 68-2-54 (1985).
SOLDERABILITY TESTING BY THE WETTING BALANCE METHOD.

See also: Sheet T-1 which deals with Methods 1, 2 and 3 of Test Ta from Publication 68-2-20.

1. INTRODUCTION

The object of this test is to determine the solderability of component terminations of any shape. The test is especially suitable for reference testing and for components that cannot be quantitatively tested by other methods.

2. GENERAL DESCRIPTION

The specimen is suspended from a sensitive balance and immersed edgewise to a set depth in a bath of molten solder at a cotrolled temperature. The resultant of the vertical forces of buoyancy and surface tension acting upon the immersed specimen is continuously measured and recorded and the recorded trace compared with that from a perfectly-wetted similar specimen.

Publication 68-2-54 considers only the "stationary mode" of testing intended to study the solderability of a particular place on the specimen.

Note.- The "scanning mode", intended to study the homogeneity of the solderability of an extended region of the surface of the specimen, is still under consideration.

If prescribed by the relevant specification, conditioning shall be preceded by accelerated ageing using one of the procedures in the last paragraph of Clause 2 of Sheet T-1.

3. SEVERITIES

Temperature of the solder bath: 235 °C
Speed of immersion and withdrawal: 20 mm/s
Duration of immersion: as prescribed by the relevant specification.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Whether degreasing is required.
b) Ageing method, if required.
c) Type of flux to be used.
d) Portion of the specimen to be tested.
e) Immersion depth.
f) Duration of immersion.
g) Parameters to be measured from the trace.
h) Acceptable values for the parameters to be measured.

SOLDERING: Test T - Publication 68-2-20 (1979) and Amendment No. 1 (1986).
RESISTANCE OF COMPONENTS TO SOLDERING HEAT: Test Tb.

See also: Publication 68-2-44 (1979): Guidance on Test T: Soldering.

1. INTRODUCTION

The object of this test is to determine the ability of a specimen to withstand the heating stresses produced by soldering.

2. GENERAL DESCRIPTION

The test provides three different methods:

Method 1A : Solder bath at 260 °C.
Method 1B : Solder bath at 350 °C.
Method 2 : Soldering iron at 350 °C.

Methods 1A and 1B are identical with Method 1 of Test Ta (see Sheet T-1), but with different immersion times and temperatures.

Method 2 is identical with Method 2 of Test Ta (see Sheet T-1), but with the iron applied to the test surface for 5 s or 10 s.

3. SEVERITIES

Method 1A

Temperature of the solder bath: 260 °C.
Depth of immersion: 2.0 mm to 2.5 mm from the body of the component or its seating plane.
Immersion time: 5 s or 10 s.

Method 1B

Temperature of the solder bath: 350 °C.
Depth of immersion: 2.0 mm to 2.5 mm from the body of the component or its seating plane.
Immersion time: 3.5 s.

Method 2

Soldering iron as for Test Ta (see Sheet T-1).
Application time: 5 s or 10 s.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Initial measurements.
b) Test method to be applied.
c) Immersion depth, if not 2.0 mm to 2.5 mm from the body of the component.
d) Immersion time.
e) Whether a thermal screen is not to be used and details of a heat sink, if required.
f) Size of soldering iron (A or B).
g) Distance of the test area from the body of the component or use of a specific heat sink.
h) Final measurements.

SOLDERING: Test T - Publication 68-2-20 (1979) and Amendment No. 1 (1986).
SOLDERABILITY OF PRINTED BOARDS AND METAL-CLAD LAMINATES: Test Tc.

See also: Publication 68-2-44 (1979): Guidance on Test T: Soldering.

1. INTRODUCTION

The object of this test is to determine the solderability and de-wetting properties of areas required to be solderable on:

a) single or double-sided metal-clad laminates;
b) single or double-sided printed wiring boards, with or without plated-through holes;
c) multilayer printed wiring boards.

Note.- Double-sided boards should have each face tested individually.

2. GENERAL DESCRIPTION

Mass soldering of printed wiring board assemblies is a manufacturing operation used widely throughout industry. One method uses flow, or wave, soldering where the printed board is fixed to a moving carrier so that it can be passed over a standing wave of molten solder. The test procedure described below is to provide a reproducible assessment of the ease, or difficulty, of obtaining a good soldered surface on any particular metal-clad board.

A rectangular specimen cut from metal-clad laminate or from single or double-sided printed wiring board is fluxed and then conveyed at constant speed in a circular path about a horizontal axis, so that the test face makes contact with the molten solder. The specimen/solder contact time is controlled with a timing device. The wetting and the de-wetting properties of the specimen are evaluated in accordance with Publications 249 and 326-2.

3. SEVERITIES

Times of contact with solder for wetting and de-wetting: see Publications 249 and 326-2.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Temperature of solder in bath.
b) Type of flux.
c) Method of accelerated ageing, if required.
d) Cleaning procedure for specimens.

SOLDERABILITY, RESISTANCE TO DISSOLUTION OF METALLIZATION AND TO SOLDERING HEAT OF SURFACE MOUNTING DEVICES (SMD): Test Td - IEC 68-2-58 (1989)

See also: IEC 68-2-44 (1979): Guidance on test T: Soldering.

1 INTRODUCTION

Test Td is applicable to Surface Mounting Devices (SMD).

The object of this test is to provide a standard procedure for determining the solderability resistance to dissolution of metallization and resistance to soldering heat of Surface Mounting Devices. The procedure uses a solder bath and is applicable only to specimens of products designed to withstand short-term immersion in molten solder.

2 GENERAL DESCRIPTION

After immersion in flux and then withdrawal the specimen is immersed in or floated on molten solder under specifiec conditions. The immersion speed shall be between 20 mm/s and 25 mm/s. Two attitudes of immersion are standardized:

Attitude A: For most specimens, the areas to be examined shall be immersed not less than 2 mm below the solder meniscus with the seating plane vertical.

Attitude B: For certain specimens, the specimen may be floated on the solder, but only when testing resistance to soldering heat.

If the relevant specification does not mention the attitude, attitude A shall be adopted.

When accelerated ageing is prescribed by the relevant specification, one of the procedures in the last paragraph of clause 2 of Sheet T-1 shall be used.

3 SEVERITIES

The duration and temperature of immersion shall be selected from the table below unless otherwise prescribed by the relevant specification.

	Severity				
Property tested	(3 ± 0,3) s (215 ± 3) °C	(2 ± 0,2) s (235 ± 5) °C	(5 ± 0,5) s (260 ± 5) °C	(10 ± 1) s (260 ± 5) °C	(30 ± 1) s (260 ± 5) °C
Wetting	X	X	—	—	—
Dewetting	—	—	X	—	—
Résistance to dissolution of metallization	—	—	—	—	X
Resistance to soldering heat	—	—	—	X	—

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) Pre-conditioning.
b) Requirements for flux*.
c) Whether pre-heating is required and the duration and temperature.
d) Whether 3 s/215 °C or 2 s/235 °C immersion conditions are required for wetting.
e) Immersion time for resistance to soldering heat test if less than 10 s.
f) Duration of the test for resistance to dissolution of metallization if less than 30 s.
g) Whether attitude A or attitude B is required in the test for resistance to soldering heat.
h) Specific areas of the specimen to be examined after wetting and requirements for visual examination*.
i) Requirements for checking and visual examination after the test for resistance to soldering heat*.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - Publication 68-2-21 (1983) and Amendment No. 1 (1985).

TENSILE: Test Ua_1.

1. INTRODUCTION

The object of this test is to determine that the terminations and attachment of the terminations to the body of the component will withstand such axial stresses as are likely to be applied during normal assembly or handling operations.

2. GENERAL DESCRIPTION

With the termination in its normal position and the component held by its body, a force is applied to the termination in the direction of its axis and acting in a direction away from the body of the component.

The force shall be applied progressively (without any shock) and then maintained for a period of 10 s.

3. SEVERITIES

a) Wire terminations (circular section or strip) or pins

The values of the force to be applied depending on the dimensions of the termination are given in the following table:

Nominal cross-sectional area mm^2	Corresponding diameter for circular-section wires mm	Force N
$S \le 0.05$	$d \le 0.25$	1
$0.05 < S \le 0.1$	$0.25 < d \le 0.35$	2.5
$0.1 < S \le 0.2$	$0.35 < d \le 0.5$	5
$0.2 < S \le 0.5$	$0.5 < d \le 0.8$	10
$0.5 < S \le 1.2$	$0.8 < d \le 1.25$	20
$S > 1.2$	$d > 1.25$	40

b) Other terminations (tag terminations, threaded studs, screws, terminals, etc.)

The value of the force to be applied shall be given in the relevant specification.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Method of pre-conditioning.
b) Initial measurements.
c) Number of terminations to be tested if more than three.
d) Force (for oversized terminations and others tested similarly).
e) Details of stripping, joining or knotting operations, if necessary.
f) Final measurements.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - Publication 68-2-21 (1983) and Amendment No. 1 (1985).

THRUST: Test Ua_2.

1. INTRODUCTION

The object of this test is to determine that the terminations and the attachment of the terminations to the body of the component will withstand thrusts such as are likely to be applied during assembly or handling operations.

This test applies only to components or parts of small dimensions and of low mass, to the exclusion of equipment and assemblies.

This test is not applicable to flexible terminations.

2. GENERAL DESCRIPTION

With the termination in its normal position and the component held by its body, thrust is applied to the termination as close as possible to the body of the component, but there should be a clear 2 mm of wire between the body of the component and the nearest point of the device applying the force.

The force shall be applied progressively (without any shock) and then maintained for a period of 10 s.

3. SEVERITIES

a) Wire terminations (circular section or strip) or pins

The values of the force to be applied depending on the dimensions of the termination are given in the following table:

Nominal cross-sectional area mm^2	Corresponding diameter for circular-section wires mm	Force N
$S \leq 0.05$	$d \leq 0.25$	0.25
$0.05 < S \leq 0.1$	$0.25 < d \leq 0.35$	0.5
$0.1 < S \leq 0.2$	$0.35 < d \leq 0.5$	1
$0.2 < S \leq 0.5$	$0.5 < d \leq 0.8$	2
$0.5 < S \leq 1.2$	$0.8 < d \leq 1.25$	4
$S > 1.2$	$d > 1.25$	8

b) Other terminations (tag terminations, threaded studs, screws, terminals, etc.)

The value of the force to be applied shall be given in the relevant specification.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Method of pre-conditioning.
b) Initial measurements.
c) Whether the test is applicable.
d) Number of terminations to be tested if more than three.
e) Direction of applied force.
f) Details of stripping if necessary.
g) Force for other than wire terminations or pins.
h) Final measurements.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - Publication 68-2-21 (1983) and Amendment No. 1 (1985).
BENDING: Test Ub (applicable to pliable terminations only)

1. INTRODUCTION

The object of this test is to determine that pliable terminations and the attachment of these terminations to the body of the component will withstand such bending loads as are likely to be applied during assembly and handling operations.

In order to be considered pliable the following conditions shall apply:

a) Test prescribed under 2a and 2c:

The termination shall be displaced during the test at least 30° with respect to its initial position.

b) Test prescribed under 2b:

The termination shall be capable of being bent with the fingers.

2. GENERAL DESCRIPTION

a) Bending (wire or strip terminations)

With the termination in its normal position, the component is held by its body in such a manner that the axis of the termination is vertical; a mass is then suspended from the end of the termination.

The body of the component is then inclined through an angle of approximately 90° in the vertical plane and then returned to its initial position; this operation constitutes one bend.

Method 1: two or more bends in opposite directions.
Method 2: two or more bends in the same direction.

b) Bending (tag terminations)

Tag terminations, capable of being bent with the fingers, shall be bent through 45° and then returned to their initial position; this operation constitutes one bend.

Method 1: two bends in opposite directions.
Method 2: two bends in the same direction.

c) Simultaneous bending (several terminations in line)

All the terminations on one side of the component shall be held, in a clamp, at the seating plane or at a point 3 mm from the seal between the termination and the body of the component. With the terminations pointing downwards a mass shall be attached to the clamp.

The body of the component is then inclined through an angle of 45° and returned to its initial position. The test shall be performed in two opposite directions.

3. SEVERITIES

The values of the force to be applied depending on the dimensions of the terminations (the section modulus Zx) are given in the following table:

Section modulus mm^3	Diameter of corresponding round leads mm	Force N
$Z_x \leq 1.5 \times 10^{-3}$	$d \leq 0.25$	0.5
$1.5 \times 10^{-3} < Z_x \leq 4.2 \times 10^{-3}$	$0.25 < d \leq 0.35$	1.25
$4.2 \times 10^{-3} < Z_x \leq 1.2 \times 10^{-2}$	$0.35 < d \leq 0.5$	2.5
$1.2 \times 10^{-2} < Z_x \leq 0.5 \times 10^{-1}$	$0.5 < d \leq 0.8$	5
$0.5 \times 10^{-1} < Z_x \leq 1.9 \times 10^{-1}$	$0.8 < d \leq 1.25$	10
$1.9 \times 10^{-1} < Z_x$	$1.25 < d$	20

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Method of pre-conditioning.
b) Initial measurements.
c) Whether the test is applicable.
d) Number of terminations to be tested, if more than three.
e) Method and number of bends, if more than two.
f) Method and particular details of application.
g) Final measurements.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - Publication 68-2-21 (1983) and Amendment No. 1 (1985).

TORSION: Test Uc (applicable only to devices with axial termination wires).

1. INTRODUCTION

The object of the test is to determine that the design of the terminations and the attachment of the terminations to the body of the component will enable them to withstand torsional forces such as are likely to be applied during assembly or dismantling operations.

2. GENERAL DESCRIPTION

The termination to be tested is bent through 90° at a point 6 mm to 6.5 mm from the point of emergence of the termination. The free end of the termination shall be clamped up to a point 1.2 mm from the bend.

Successive rotations shall be in alternate senses at a rate of one rotation per 5 s.

Method A - The body of the component is clamped and rotated about the original axis of the termination, whilst the clamp on the bent termination is rigidly held.

Method B - For components with a body unsuitable for clamping (e.g. having a diameter less than 4 mm) and with axial terminations of the same kind at each end, both terminations shall be bent and clamped. One of these terminations shall be rotated about its original axis and the other be rigidly held.

3. SEVERITIES

Method A - Component body clamped.

Severity 1: three rotations of 360°
Severity 2: two rotations of 180°

Method B - Both wire terminations clamped.

Two rotations of 180°

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Method of pre-conditioning.
b) Initial measurements.
c) Whether the test is applicable.
d) Number of terminations to be tested, if more than three.
e) Severity (Method A).
f) Final measurements.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - Publication 68-2-21 (1983) and Amendment No. 1 (1985).

TORQUE: Test Ud.

1. INTRODUCTION

The object of this test is to determine that the terminations, the attachment of the terminations to the body of the component and integral mounting means will withstand torque forces such as are likely to be applied during assembly or handling operations.

2. GENERAL DESCRIPTION

For terminations with threaded studs or screws the torque given in the table below is to be applied to the screw or to each of the nuts normally fitted to each terminal to be tested for a period of 10 s to 15 s according to the severity prescribed by the relevant specification.

During this test, a washer or metal plate with a normal clearance hole for the screw thread shall be placed between the screw head and the surface on to which it is tightened.

For other types of termination the relevant specification shall give the method required.

3. SEVERITIES

Nominal thread diameter (mm)		2.6	3.0	3.5	4.0	5.0	6.0
Torque (N.m)	Severity 1	0.4	0.5	0.8	1.2	2.0	2.5
	Severity 2	0.2	0.25	0.4	0.6	1.0	1.25

For some components, such as semiconductor devices, very different torque values may be needed. Where necessary, these shall be prescribed in the relevant specification.

For diameters greater than 6 mm, the torque values shall be prescribed by the relevant specification.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Method of pre-conditioning.
b) Initial measurements.
c) Whether the test is applicable.
d) Number of terminations to be tested, if more than three.
e) Severity.
f) Different torque values for thread diameters greater than 6 mm or if necessary for other reasons.
g) Test method for other types of terminations.
h) Final measurements.

ROBUSTNESS OF TERMINATIONS AND INTEGRAL MOUNTING DEVICES: Test U - IEC 68-2-21 (1983) and Amendment 1 (1985)

SURFACE MOUNTING DEVICES (SMD) IN THE MOUNTED STATE (APPLICABLE TO SMD): Test Ue - Amendment 2 (1991)

1 INTRODUCTION

The object of this test is to assess the mechanical robustness of surface mounting device (SMD) terminations mounted on a substrate by a specified method. The terminations consist of short partly flattened metallic parts, similar to conventional terminations.

2 GENERAL DESCRIPTION

Test Ue contains three separate test methods and the relevant specification shall state which is applicable. These methods are:

Test Ue1: Bending test - This test is suitable for all devices except those intended for mounting on rigid substrates only.

The test substrate with the specimen is placed in the bending jig and gradually bent to a depth of 1 mm, 2 mm, 3 mm, or 4 mm. The value of the tolerance shall be prescribed by the relevant specification. The substrate shall be maintained in the bent state for 5 s ± 1 s, unless some other time is prescribed by the relevant specification. Then the bending force shall be relaxed.

Test Ue2: Pull-off test - This test is suitable for devices intended for mounting on rigid substrates.

With the substrate firmly held, a pulling force shall be applied to the specimen along an axis within 5° of normal and its value gradually increased to that prescribed by the relevant specification and maintained for the prescribed time before being relaxed.

Test Ue3: Shear test

When permitted by the type and geometry of the specimen, a force shall be applied to it by means of an appropriate pushing tool. The tool shall be brought without shock into contact with the specimen, and then the force shall be gradually increased at a constant rate to the value prescribed by the relevant specification and maintained for the prescribed time before being relaxed.

If prescribed by the relevant specification, a suitable critical parameter shall be monitored throughout the period during which the specimen remains bent under test (Test Ue1) or throughout the period during which the force is applied (Tests Ue2 and Ue3).

The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

3 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Test method and for tests Ue2 and Ue3, the substrate and all additional details, including whether a specimen may be a non-operative device and the need for a final conditioning.
b) Number of specimens required.
c) Dimensions of soldering lands on the substrate.
d) Method of mounting.
e) When the bending test (Ue1) is specified, the depth of bend and time of remaining bent if other than 5 s and any required monitoring.
f) For the pull-off test (Ue2), values of force and time and any required monitoring.
g) For the shear test (Ue3), values of force and time and any required monitoring.
h) Criteria for acceptance or rejection.

IMMERSION IN CLEANING SOLVENTS: Test XA - Publication 68-2-45 (1980).

1. INTRODUCTION

The object of this test is to determine the effects of prescribed cleaning solvents on electronic components and other parts suitable to be mounted on printed boards when subjected to immersion in the specified cleaning solvents.

This test is not intended to simulate the effects of handling.

2. GENERAL DESCRIPTION

The specimens are completely immersed in a solvent at a specified temperature for a specified time.

Note.- Successful compliance with this test does not imply resistance to other solvents.

Two commonly used solvents are specified for the purpose of this test:

a) a mixture of 1,1,2-trichlorotrifluoroethane, 70 by mass and 2-propanol (isopropyl alcohol), 30 by mass. Commercially available grades (industrial use) are used.

b) demineralized or distilled water having a resistivity of not less than 500 Ω·m, the corresponding value of conductivity being 2 mS/m.

In technically justified cases other solvents similar in activity to the recommended ones may be used as prescribed in the relevant specification.

Two methods are specified, namely:

- Method 1 with rubbing
- Method 2 without rubbing.

When using Method 1, the specimens are allowed to dry for at least 5 min after removal from the solvent. Then the marking area is rubbed with cotton wool or with wrapping tissue paper.

3. SEVERITIES

Solvent temperature: For the solvent specified in 2a): 23 °C or 48.6 °C to 50.5 °C (boiling temperature)

For the solvent specified in 2b): 55 °C.

Duration of immersion: 5 min.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Solvent to be used.
b) Solvent temperature.
c) Initial measurements, if any.
d) Conditioning (Method 1 or Method 2).
e) Rubbing material (cotton wool or tissue paper).
f) Recovery time, if different from 1 to 2 h.
g) Final measurements.

COMPOSITE TEMPERATURE/HUMIDITY CYCLIC TEST: Test Z/AD - Publication 68-2-38 (1974).

See also: Publication 68-2-28: Guidance for Damp Heat Tests (1980) (and Publication 260: Test Enclosures of Non-injection Type for Constant Relative Humidity (1968)).

1 INTRODUCTION

The object of this test is to provide a composite test procedure, primarily intended for component type specimens, to determine in an accelerated manner the resistance of specimens to the deteriorative effects of high temperature/humidity and cold conditions.

2. GENERAL DESCRIPTION

The test employs temperature cycling at high relative humidity and will produce an entry of moisture, by "breathing", into partially sealed containers.

The test includes exposure to low temperatures to determine the effects of periodic icing.

The temperature can be varied between 25 °C and 65 °C in a period of between 1.5 h and 2.5 h for both rising and falling temperatures.

The relative humidity is maintained at 93% during the periods of constant or rising temperature and between 80% r.h. and 96% r.h. during the following temperature periods.

3. SEVERITIES

The number of 24 h cycles is 10, unless otherwise specified. If other than 10, the relevant specification will define the number and the position of the cold cycles in the sequence.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) State of specimen during conditioning (for example, electrical or mechanical loading or polarizing voltage).

b) Pre-conditioning procedure if other than condition for "assisted drying".
c) Conditions for initial measurement of other than standard atmospheric conditions for testing.

d) Electrical and mechanical checks to be made prior to test.
e) Electrical and mechanical checks to be made during conditioning if these are required and periods after which they shall be performed.
f) Electrical and mechanical checks to be made after conditioning, parameters to be measured first, and periods after which measurement of these parameters shall be completed if other than standard.

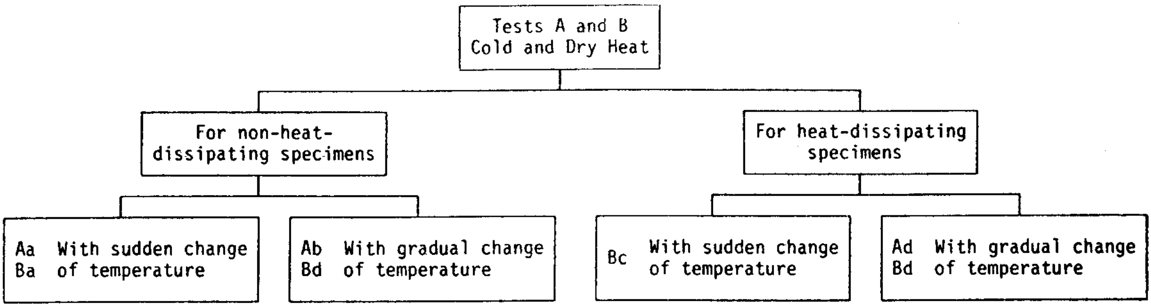
COMBINED COLD/VIBRATION (SINUSOIDAL) TESTS: Tests Z/AFc - Publication 68-2-50 (1983).
COMBINED DRY HEAT/VIBRATION (SINUSOIDAL) TESTS: Tests Z/BFc - Publication 68-2-51 (1983).

See also: Sheets A/B-1 and F-1; Publications 68-3-1: Background Information. Section One - Cold and Dry Heat Tests (1974) and 68-3-1A (1978) and also Publication 68-2-53: Guidance to tests Z/AFc and Z/BFc: Combined Temperature (Cold and Dry heat) and Vibration (Sinusoidal) Tests (1984).

1. INTRODUCTION

These Tests deal with combined cold or dry heat and vibration (sinusoidal) tests applicable to both heat-dissipating and non-heat-dissipating specimens. They are basically combinations of Test Fc and Guidance: Vibration (sinusoidal) (Publication 68-2-6) and Tests A: Cold (Publications 68-2-1 and 68-2-1A) or Tests B: Dry Heat (Publications 68-2-2 and 68-2-2A).

The cold and dry heat tests are subdivided as in the block diagram below.


Tests A and B
Cold and Dry Heat
For non-heat-dissipating specimens
For heat-dissipating specimens
Aa Ba With sudden change of temperature
Ab Bd With gradual change of temperature
Bc With sudden change of temperature
Ad Bd With gradual change of temperature

The procedures given in these tests are normally intended for specimens which achieve temperature stability during the performance of the cold or dry heat elements of the test.

2. GENERAL DESCRIPTION

Tests Ab, Bb and Bd require that during the heating and cooling phases of temperature conditioning the rate of change of temperature does not exceed 1 K/min averaged over a period of 5 min. The maximum rate of change of temperature of 1 K/min does not apply to specimens which are capable of withstanding thermal shock, that is specimens that are normally subjected to Test Aa or Ba and are capable of withstanding rapid change of temperature Test Na or Nc. For these specimens, chambers capable of maintaining the conditions specified for Tests Aa, Ba or Bc (sudden change of temperature) may be used.

Unless Tests A/B and Fc have been performed (and the results recorded), a vibration test under laboratory temperature conditions is first performed and the specimen is then subjected to the low/high temperature until temperature stability has been reached, after which it is subjected to the combination of vibration and low/high temperature. The vibration environment should be selected from: endurance by sweeping (preferred); vibration response investigation plus endurance at those frequencies derived from the vibration response investigation; endurance at predetermined frequencies. A vibration response investigation after endurance conditioning is not included in these combined tests.

3. SEVERITIES

The vibration severity is defined by the combination of frequency range, vibration amplitude and duration of endurance (in sweep cycles or time) taken from Test Fc (Publication 68-2-6). The temperature values are chosen from Tests A (Publication 68-2-1) or Tests B (Publication 68-2-2).

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Rate of change of temperature: sudden (Tests Aa, Ba or BC) or gradual (Tests Ab or Ad, Bb or Bd).
b) Details of mounting and/or supports.
c) Severity.
d) Pre-conditioning.
e) Initial measurements.
f) Axis (axes) of vibration.
g) State of specimen during conditioning.
h) Functional check.
i) Vibration test procedure (endurance by sweeping, or at response frequencies, or at predetermined frequencies).
j) Recovery if non-standard.
k) Measurements and loading during conditioning.
l) Final measurements.
m) Criteria of failure.

Z/AM
Z/BM

COMBINED COLD/LOW AIR PRESSURE TESTS: Test Z/AM: Publication 68-2-40 (1976) and Amendment No. 1 (1983).
COMBINED DRY HEAT/LOW AIR PRESSURE TESTS: Test Z/BM: Publication 68-2-41 (1976) and Amendment No. 1 (1983).

See also: Sheets A/B-1 and M-1; Publications 68-3-1: Background Information. Section One - Cold and Dry Heat Tests (1974) and 68-3-1A (1978) and also Publication 68-3-2: Background Information. Section Two - Combined Temperature/Low Air Pressure Tests (1976).

1. INTRODUCTION

The object of these tests is to determine the ability of components, equipments or other articles to be stored and used under a simultaneous combination of high or low temperature and low air pressure.

These combined tests should normally be used only if the effects of combined environments will not be revealed by subjecting the specimen to single environments. The procedures are limited to the case of specimens which achieve temperature stability during the test procedure.

In the case of heat-dissipating specimens, these procedures apply only to the testing of one specimen at a time.

2. GENERAL DESCRIPTION

The specimen is first subjected to the appropriate severity of dry heat or cold as indicated in the relevant specification. In the case of operational tests, a check is then made to ensure that the specimen is capable of operation. With the temperature maintained at the indicated value, the chamber air pressure is then reduced to the appropriate severity as specified in the relevant specification. These conditions are maintained for the specified duration.

Heat dissipating specimens are preferably tested without forced air circulation in the chamber according to Test Ad (Cold) or to Test Bd (Dry heat). When the chamber used for testing is large enough to meet the conditions specified for Test Ad or Test Bd, but cooling or heating of the chamber can only be carried out by forced air circulation, Method A of Test Ad or Test Bd can be applied.

Non-heat-dissipating specimens may be tested in a chamber with or without forced air circulation.

3. SEVERITIES

Test Z/AM			
Temperature °C	Air pressure		Duration h
	kPa	mbar	
-55	4	40	2
-55	15	150	2
-55	25	250	2
-55	40	400	2
-40	55	550	2, 16
-25	55	550	2, 16
-40	70	700	2, 16

Test Z/BM			
Temperature °C	Air pressure		Duration h
	kPa	mbar	
85, 155	4	40	2
55, 85, 155	15	150	2
55	25	250	2
55	40	400	2
55	55	550	2, 16
55	70	700	2, 16
40	55	550	2

The temperature and low air pressure values, tolerances and durations shall comply with those given in Tests M and either Ab or Ad or Bb or Bd.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Pre-conditioning.
b) Initial measurements.
c) Details of mounting or supports (applicable to heat-dissipating specimens).
d) State of specimen including cooling system.
e) Severity: temperature, pressure and duration of exposure during conditioning.
f) Checks to be made at low or elevated temperature before reducing the air pressure.
g) Checks, measurements, and/or loading during the cold or dry heat/low air pressure conditioning.

h) Loading condition during recovery.
i) Final measurements.

Z/AMD

COMBINED SEQUENTIAL COLD, LOW AIR PRESURE AND DAMP HEAT TEST: Test Z/AMD - Publication 68-2-39 (1976).

See also: Sheets A/B-1 and M-1.

1. INTRODUCTION

The object of this test is to provide a standard procedure consisting of the application of cold, low air pressure and damp heat; the first two conditions in combination and the second condition combining with the third during the sequential transition from the first. The tests employed are Tests A and Test M, but although introduction of moisture is not exactly in accordance with Test D, this letter has been used in the identification Z/AMD as being the most appropriate and informative.

2. GENERAL DESCRIPTION

The test is primarily intended for components and equipment used in aircraft. It simulates the conditions encountered within unpressurized and non-temperature-controlled zones of an aircraft during ascent and descent. A non-heat-dissipating component that incorporates elastomeric seals (such as a plug-and-socket connector) will experience hardening of the seals and contraction of materials as it becomes cold, and may suffer failure of such seals, with consequent loss of internal pressure, as the surrounding air pressure decreases. When the aircraft descends into a humid atmosphere and the air pressure increases again, the cold component suffers frosting and the humid atmosphere itself, or free water formed by the melting of the frost, may be driven into the component by the differential pressure and be trapped inside by the seals as they recover their normal elasticity. The same sequence may cause water or ice to accumulate inside a piece of equipment with an unsealed but closely-fitting cover but without drain holes.

The air temperature and pressure in the chamber are reduced to the prescribed values. With the pressure at the low value, the temperature is raised whilst at the same time admitting steam so as to form frost. When the temperature has reached the room temperature, the relative humidity is maintained above 95%.

3. SEVERITIES

Tests A: Cold
Temperature °C
-65
-55
-40
-25
-10
-5
+5

Test M: Low air pressure values	
Air pressure	
kPa	mbar
1	10
2	20
4	40
8	80
15	150
25	250
40	400
55	550
70	700
84	840

Relative humidity
%
>95

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

a) Severity: value of low temperature and value of low pressure (selected from Tests A and M).

b) Pre-conditioning procedure.
c) Electrical and mechanical checks to be made before conditioning.
d) Mounting attitude of the specimen in the test chamber and any special instructions; for example, mating and wiring of plug-and-socket connectors.
e) Electrical and mechanical checks to be made at the low temperature, low pressure condition.

f) Electrical and mechanical checks to be made at the maximum temperature, high humidity condition.

g) Number of cycles of low temperature/low pressure/damp heat.
h) Electrical and mechanical checks to be made after recovery.

CLIMATIC SEQUENCE: TEST Z/ABDM - IEC 68-2-61 (1991)

See also Sheets A/B-1; Db and M.

1 INTRODUCTION

The object of this test is to provide standard composite test methods for determining the suitability of specimens products, primarily components, when subjected to environmental conditions consisting of a sequence of temperature, humidity and, where required, low air pressure environmental stresses.

The order of the application of the stresses, and the conditions for the change from one step to the next, have been chosen to accelerate and amplify degradation mechanisms of the same type as those observed under natural climatic conditions.

The test is frequently specified to follow other tests involving mechanical stress, for example tests for robustness of terminations, solderability, shock and vibration, as a means of determining whether the sealing of the specimen has been damaged.

2 GENERAL DESCRIPTION

Three methods are standardized. Method 1 is preferred and shall always be used unless otherwise prescribed bv the relevant specification.

- *Method 1* contains five steps, of which one is optional (low atmospheric pressure). In method 1 the specimen is first exposed to a high temperature and then to a cycle of damp heat. The damp heat cycle is immediately followed by a low temperature test so that any moisture which has entered the specimen or the surface cracks in its seals will be frozen and cause further damage. Low air pressure (optional) is then followed by further exposure to cyclic damp heat conditions (except for climatic categories —/—/04 and —/—/10) to complete the check on the sealing of the specimen.
- *Method 2* defines a more severe testing which interposes a low temperature test between each of the final damp cycles (climatic category —/—/56).
- *Method 3* is intended to provide a short climatic sequence for lot-by-lot acceptance testing, applicable, where prescribed by the relevant specification, to electronic components of assessed quality.

3 SEVERITIES

The tables can be deleted and replaced by clause 5 of the standard as follows:

The severity is defined by the temperature of the dry heat test (table of clause 3 of sheet A/B-1), the temperature of the cold test (table of clause 3 of sheet A/B-1), the air pressure and the duration of exposure, if the optional "low air pressure" step is required (table and last paragraph of clause 3 of sheet M-1), and finally the number of damp heat cycles determined by the climatic category as follows, unless otherwise prescribed by the relevant specification:

Climatic category	—/—/04 and —/—/10	not applicable
	—/—/21	1 cycle
	—/—/56	5 cycles

4 INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

Particular attention shall be paid to the items marked with an asterisk (*) which indicates that this information is always required:

a) When pre-conditioning is not required.
b) Initial measurements*.
c) Method (if not method 1).
d) Recovery.
e) Temperature for dry heat tests.
f) Intermediate measurements.
g) Requirements for damp heat test, variant and temperature.
h) Temperature for cold test*.
i) When low atmospheric pressure test is required.
j) Severity for low atmospheric pressure test.
k) When electric strength test is required and the conditions.
l) Number of cycles of damp heat test.
m) Final measurements*.
n) Extended recovery.

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